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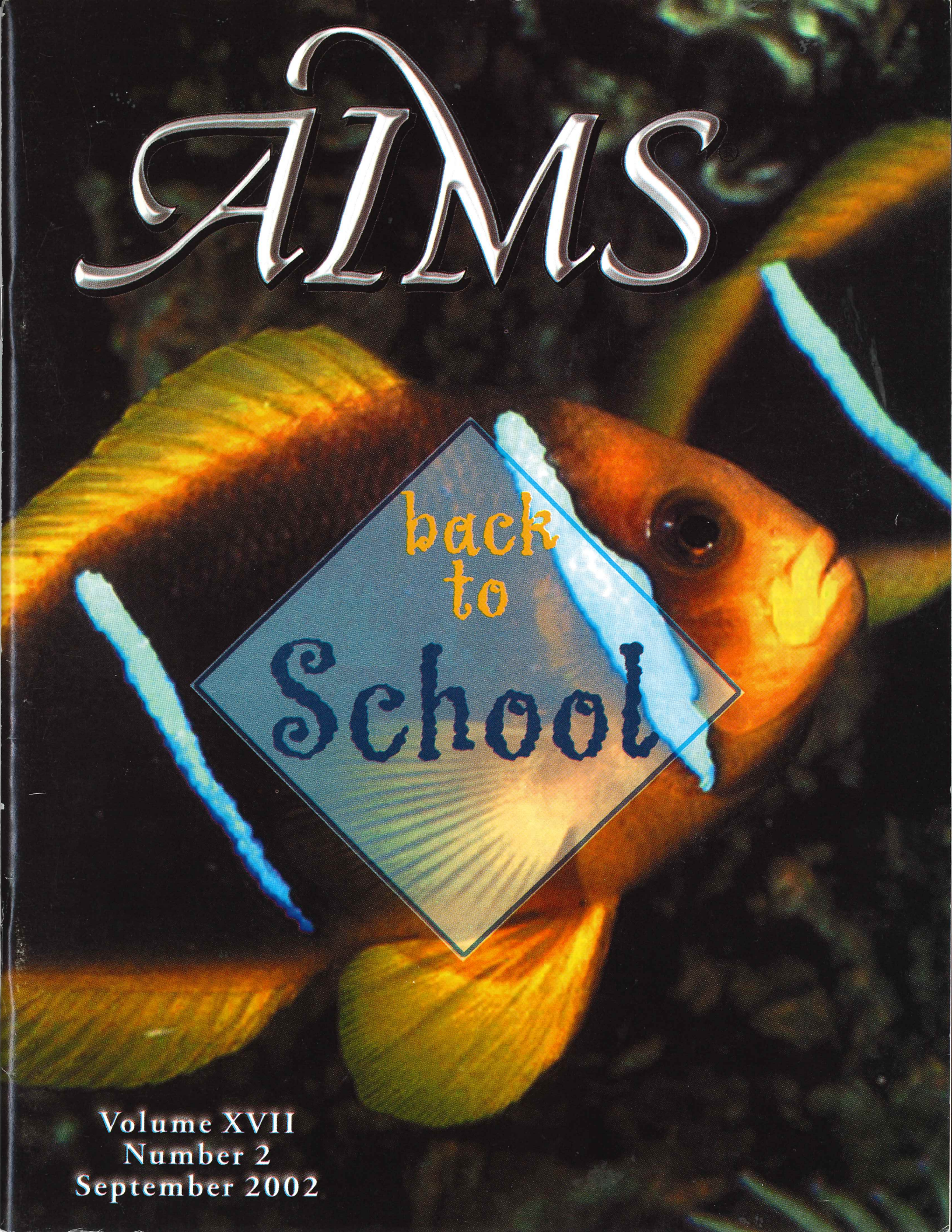

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In This Issue

The AIMS Education Foundation is committed to offering the finest staff development using as many delivery systems as possible. One of those delivery systems is this magazine. In this issue we have provided you with math and science activities that address the following national standards: *Project 2061 Benchmarks for Science Literacy* (American Association for the Advancement of Science, *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics), and *National Science Education Standards* (National Research Council of the National Academy of Sciences). Check your local standards to find the fit; we find that most state standards align with these national ones.

Other delivery systems for our staff development are our one or two day workshops that can be custom designed to meet your needs, one week workshops, and a series of workshops called *AIMS by Design®*. *AIMS by Design®* workshops are held in selected sites across the United States. We invite you to send a team of teachers to these workshops. See pages 28 and 29 for our fall locations. You can also watch the AIIMS web site for continuous updates of this great program.

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Vol. XII (1997-98)
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Vol. XV (2000-01)
Vol. XVI (2001-02)

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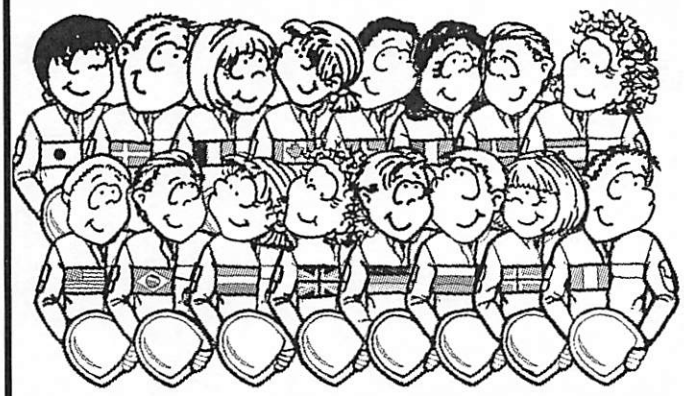
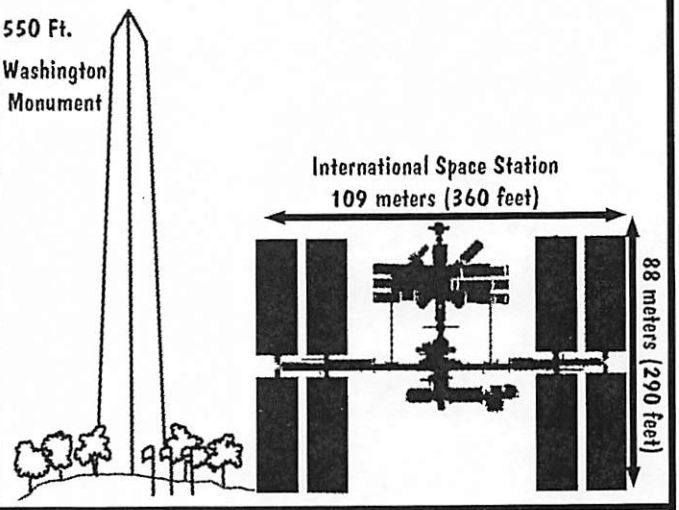
Isn't It Interesting...

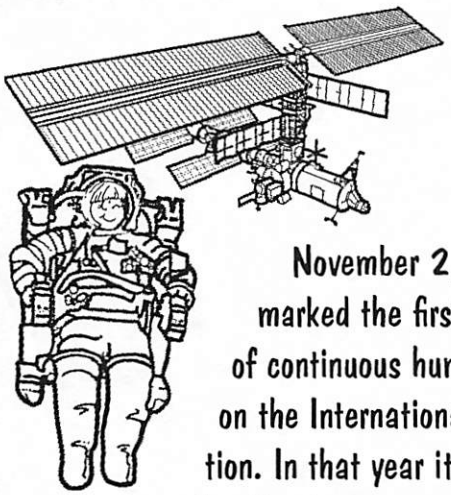
Space Out



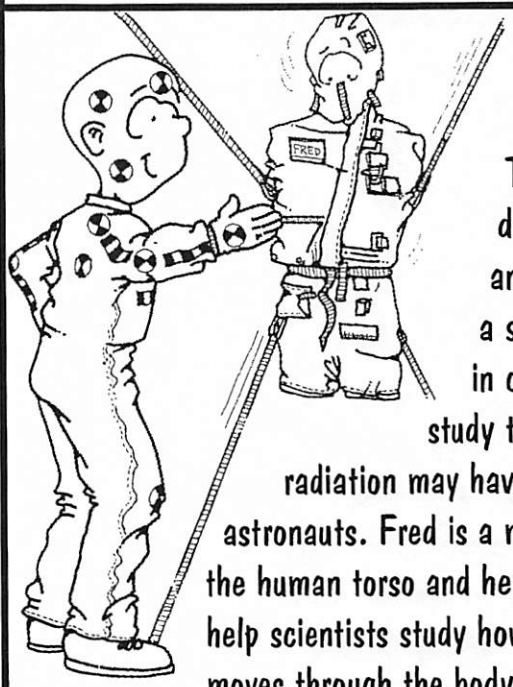
Sixteen nations contribute to the construction and upkeep of the International Space Station. They are the United States, Canada, Japan, Russia, Brazil, and 11 nations that belong to the European Space Agency.

The mass of the space station will be about 453,600 kilograms (1,000,000 pounds). It will measure about 109 meters (360 feet) across and 88 meters (290 feet) long.





November 2, 2001 marked the first anniversary of continuous human presence on the International Space Station. In that year it was home to five Russian cosmonauts and four NASA astronauts.



Fred the Phantom Torso was developed and sent for a shuttle ride in order to study the effects radiation may have on the astronauts. Fred is a model of the human torso and head and will help scientists study how radiation moves through the body.

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Trading Boards

by Judith Hillen

Topic
Place Value Numeration

Learning Goal
Students will engage in a series of trading experiences to build capacity for place value concepts by using grouping materials at various stages.

Guiding Document
*NCTM Standards 2000**

- *Understand numbers, ways of representing numbers, relationships among numbers, and number systems*
- *Use multiple models to develop initial understandings of place value and the base ten number system*
- *Develop a sense of whole numbers and represent and use them in flexible ways including relating, composing, and decomposing numbers*
- *Connect number words and numerals to the quantities they represent, using various physical models and representations*

Materials
For each pair of students:

125 straws or sticks
10 rubber bands
20 beans, lima or kidney
20 bean poles—flat craft sticks with ten beans glued to each stick
10 bean flats—10 bean poles taped to make a raft
coins—20 pennies, 25 dimes, and 3 dollars (real or make-believe)
Base Ten Blocks—20 cubes, 25 longs (rods), and 5 flats
30 blue plastic counting chips
Trading Boards, one per pair of students

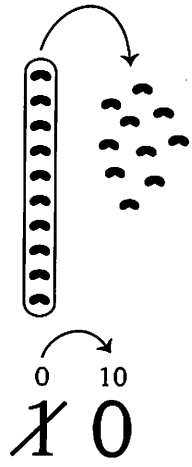
Background Information
Children learn place value concepts at the manipulative level. For this reason, a sequence of experiences is developed to guide the student from the manipulative level to the abstract. Each stage builds on the preceding one and increases in its abstraction. This lesson presumes that students can gather one bundle of ten sticks and three loose sticks to represent 13, for example.

When using sticks, beans, coins, or Base Ten Blocks, the trades are based on students understanding how to group materials in hundreds, tens, and ones and are prompted by visual clues because of the proportional nature of the materials.

The most abstract level of thinking occurs when the shift is made to Stage Five, which is chip trading. The value of the chip is determined by the position or place value of each chip relative to the number base. When using the blue chips, all visual clues such as size or shape are removed, and students have to shift their thinking to trades based on the position or the place value of the chip.

Stage One: Sticks, Bundles, and Super Bundles
These manipulatives are ideal for initial use with young learners because they can be counted and grouped into bundles of ten. Each placement of a rubber band around a bundle is an experience of regrouping into ten and is a model for carrying from the units place to the tens place. Conversely, removing a rubber band or unbundling is a model for borrowing. Super bundles of ten tens represent hundreds.

Stage Two: Beans, Bean Poles, and Flats
Individual beans represent ones, ten beans glued to a flat stick or tongue depressor represent tens, and tens sticks side by side become a raft representing one hundred. This model cannot be "unbundled" as the previous one, so "trading" becomes a requirement. It is appropriate here to model the connection of trading a bean stick for ten loose ones to the pencil-paper record of crossing out a ten and moving ten to the units place.



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Stage Three: Pennies, Dimes, and Dollars

This manipulative could be "play" money or real coins. The value given to the coins we use today was originally an arbitrary decision not based on the size of the coin. Consequently this model is more abstract for students but still a friendly model to them because of its real-world application. Exchanging ten coins for one of greater value represents carrying and trading one for ten of lesser value is a model for borrowing.

Stage Four: Base Ten Blocks or Dienes Blocks or DigiBlocks

This proportional model consists of cubes, longs, and flats representing ones, tens, and hundreds respectively. Trading is necessary for carrying and borrowing.

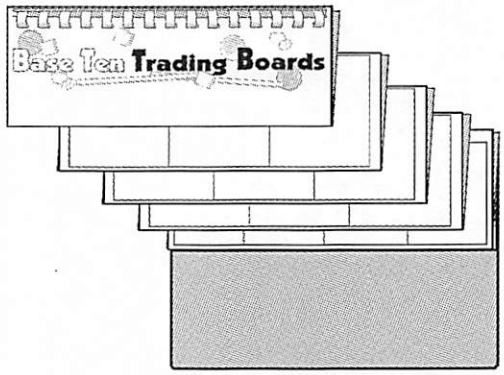
Stage Five: Blue Chip Trading

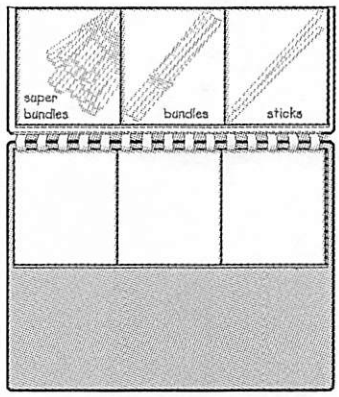
This manipulative consists of using chips of one color and trading is based on the position or place value of the chip rather than its value, size, or appearance. A move from one place or column to the next represents a ten for one trade in the base ten number system.

Management

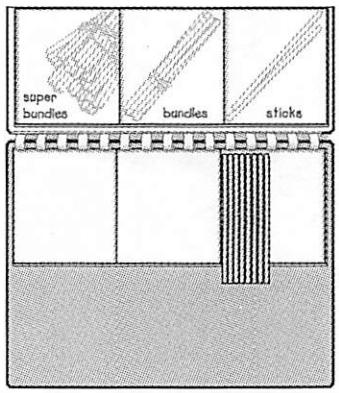
1. Students may work in pairs to share materials and to maximize oral communication and mathematical language.
2. Because the management of large sets of materials such as sticks to represent hundreds of units, it is suggested that in its initial use, numbers be selected to reflect ease of handling and convenience for the classroom.
3. It is strongly recommended that considerable attention be given to using the trading boards to build and take apart numbers and then to move to simple addition with carrying and simple subtraction with borrowing or regrouping. A sample set of numbers to build and decompose is given as well as a sample set of addition and subtraction problems. These sets may be used with any of the manipulatives.
4. Select the manipulatives according to the readiness of the students. Beginners, perhaps first and second graders, would do well at Stage One or Two with sticks and bundles and beans and bean poles. Intermediate students in third and fourth grades might work well at Stages Three and Four with pennies, dimes, and dollars and with Base Ten Blocks. Stage Five, Blue Chip Trading requires that students are able to shift to using a model that relies exclusively on their understanding of place value trades. This may be appropriate for third through sixth graders.
5. The Trading Boards are used to build conceptual understanding of grouping and place value. This experience is about process and therefore no written records are provided.
6. Trading Boards can be constructed using plastic "finger" bindings, spirals, or by placing the boards in three-ring binders.

7. Fold each page in half so that the print side is on the outside. (The open long edges of the folded paper will be punched to hold the bindings.) Stack the pages as illustrated. The last page of the Trading Board should be a sheet of card stock (8.5" x 11").





8. Students can flip the pages of the Trading Board until they find the manipulative that is being used in class. They will perform their work on the portion of the trading board located under the labels.



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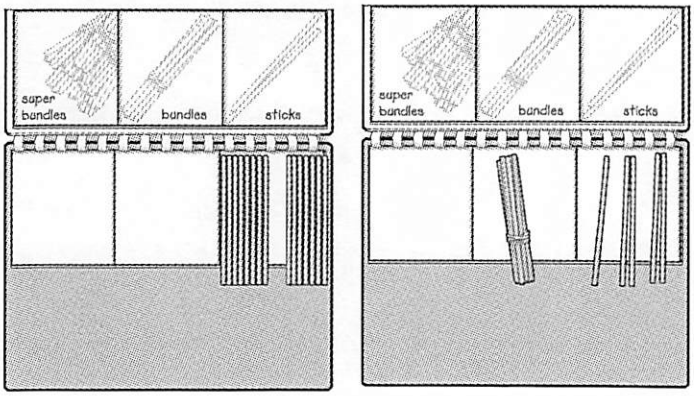

Procedure

Stage One: Trading Boards with Sticks, Bundles, and Super Bundles

1. Distribute 125 sticks, 10 rubber bands, and a Trading Board to each pair of students.
2. Explain to students that they are going to count and bundle sticks to represent numbers. One rule that they need to remember is that every set of TEN is bundled with a rubber band.
3. Each set of manipulatives requires that students group and ungroup materials in ways unique to the level of sophistication of the materials.
4. Begin by constructing numbers with loose sticks and then grouping the sticks to show sets of ten.
5. Move to simple addition and subtraction problems. See *General Instructions for Trading Boards.*

Stage Two: Trading Boards with Beans, Bean Poles, and Flats

6. For Trading Boards with beans, bean poles, and flats, distribute two bean flats, 100 bean poles and 20 loose beans to each pair of students. With this manipulative, each set of ten beans is glued to a stick or pole and thus must be traded for carrying, borrowing or re-grouping. Follow directions for *General Instructions Trading Boards.*

Stage Three: Trading Boards with Pennies, Dimes,and Dollars

7. Use real or make believe money and maintain the base ten relationship. Distribute three dollars, 25 dimes, and 20 pennies to each pair of students. Use the Trading Boards and general instructions.

Stage Four: Trading Boards with Base Ten Blocks

8. Distribute five flats, 25 longs, and 20 cubes to each pair of students. Use the Trading Boards and follow the general instructions.

Stage Five: Blue Chips

9. For *Blue Chip Trading,* distribute 30 blue counting chips and follow the general directions for trading.

Discussion

Questions 1–5 are designed for use with each of the manipulatives. The examples are stated using sticks. Adjust for other manipulatives.

Using sticks, bundles and super bundles:

1. Explain how the sticks are used to build a single digit number. [Each stick represents a single count.]
2. How is building a two-digit number different from a one-digit number? [Loose sticks show a single counts in the ones place and ten bundled together represents "counts" in the tens place.]
3. Describe two different ways sticks can show 23. [2 bundles and 3 sticks or 23 sticks]
4. How are sticks and bundles used to add 23 and 8? (Explanations will vary but should include idea of grouping 10 sticks to make a bundle of ten.)
5. When adding 23 and 8, describe "old tens" and "new tens." [New tens are the result of re-grouping the ones to make ten.]

Questions 6-7 ask students to work with two models and to compare their likenesses and differences.

6. Use sticks and bundles to solve a simple addition problem such as 19 + 4. Now try the same problem with bean sticks and beans. How are the methods the same of different?
7. Use the base-ten materials to subtract 7 from 100. Describe the process of re-grouping. How does this connect to the paper-pencil record of the problem and its solution?

Questions 8-9 ask students to use the blue chips and explain how the value of a number is determined.

Blue Chip Trading

8. Use the blue chips to "picture" 123. Explain how just six chips represents 123. [The value of the number is determined by the position or place value of each chip. One chip in the hundreds place, 2 in the tens place, and 3 in the ones place.]
9. Describe the numerical value of this picture.

Hundreds	Tens	Ones
● ●	● ● ● ● ●	● ● ●

$2(100) + 5(10) + 3 = 253$

$200 + 50 + 3 = 253$

Extension

1. Describe to students the rules for the game *Let's Roll!* The game uses a die to generate numbers to be represented on a trading base ten board using blue chips. See directions for *Let's Roll.*

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Let's Roll

Number of Players
Two to four players

Materials
One trading board per player
One die
Thirty blue chips per player

Instructions
1. Begin with a clean board.
2. Each player in turn rolls one die to determine how many chips to place on the board in the ones place.
3. Make trades as necessary.
4. First player to reach 100 wins.

Variations
1. Use a four column Trading Board and play to 1000.
2. Instead of chips, use any one of the manipulatives such as beans, beanpoles, and flats or pennies, dimes and dollars, or Base Ten Blocks.
3. Begin with one chip in the hundreds place. For each roll of the die, take away that many ones (units). First player to reach zero wins.

General Instructions for Trading Boards

Materials
Beginners: Stage 1, 2 materials
Intermediate: Stage 3, 4 materials
Advanced: Stage 5—Blue Chip Trading

Learning Goals

The students will be able to represent any one–two– or three–digit number flexibly with a variety of manipulatives. For example, 23 can be pictured as 2 bundles and 3 sticks; or 2 beanpoles and 3 beans; or 2 dimes and 3 pennies; or 2 rods and 3 cubes.

Students will use manipulatives to show the meaning of adding and subtracting numbers and the related grouping and place value concepts.

Build a Number

Students use the Trading Boards to display the grouping of manipulatives to represent a number.

Display: 3, 7, 12, 24, 38.

Interact with partners: Students share aloud with each other their thinking about how the materials were used to build each number.

Addition of Numbers

Students use the Trading Boards to add two or more two and three digit numbers that require carrying.

Display these sample problems:

8	19	23	46	78	125
+ 7	+ 4	+ 8	+ 7	+ 43	+ 82

Share work and process with team.

Subtraction of Numbers

Students use the Trading Boards to subtract two numbers that require borrowing.

Display:

10	21	46	102	100
- 8	- 7	- 9	- 19	- 31

Share work and thinking with partners.

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Base Ten Trading Boards

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pennies

dimes

dollars

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	ones
	tens
	hundreds

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				ones
				tens
				hundreds
				thousands

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	ones
	tens
	hundreds

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thousands	hundreds	tens	ones

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		thousands	hundreds	tens	ones

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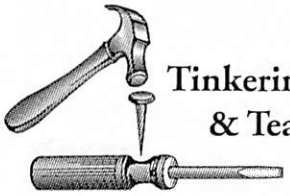

Tinkering, Toys, & Teaching

Simple Circuits

by Jim Wilson

Electrical projects have long been a student favorite. There's a learner's satisfaction and sense of achievement in connecting pieces of wire to a battery and getting a bulb to light or a motor to run. I've never had to motivate students, from the primary grades to the graduate level, to participate in an electrical activity or project.

But times have changed. Traditional electrical projects seem old and dated. In our modern world of solid-state electronics, it's hard to identify and connect "electrical circuits" with the electronic devices we use daily. In these modern devices, it's difficult to find and trace the circuits that were once readily visible. (Gone are the days of being able to look into the back of a radio and see the forest of glowing tubes that made the radio work.)

This column is the first in a continuing series of columns designed to develop and update what is learned in the traditional "electrical circuit" study unit to include an introduction to "electronics."

A modern tool for learning and exploring electronics is a four- by two-inch plastic board called a solder-less breadboard. A breadboard is full of holes and the wire leads of light-emitting diodes, resistors, transistors, capacitors, and logic chips can be inserted into the holes without the need for soldering. Short pieces of wire are used to connect components and build circuits.

Once you've purchased the nonconsummable materials listed below, they can be used to construct an almost limitless number of projects. I plan to describe in this column one or two breadboard projects per year. Each project will build on the previous project so that over time, considerable sophistication can be achieved. By reusing the same materials to do different things, the focus is placed on the concepts embedded in each project instead of the materials.

Materials

From Radio Shack

(Go to your local Radio Shack® and give the clerk the catalog numbers. The clerk will know exactly what rack to go to. Buying the correct parts is as simple as that.)

1 solder-less breadboard
Part Number 276–175
$7.99

1 AA battery (2) holder
Part Number 270-382
$1.29

1 heavy-duty 9v snap connector
Part Number 270-324
$1.89/Pkg. of 5

2 mini-alligator clips
Part Number 270-380
$2.29/Pkg. of 12

Other materials:

2 size AA batteries

bell wire (Stranded wire will not work with this project. A ten-meter spool of bell wire is available from the AIMS catalog, #1968, for $2.95.)

Tools

Wire stripper (A wire stripper, #1970, is available from the AIMS catalog for $3.95.)

Needle nose or regular pliers (handy but not required)

Soldering iron (optional)

Building the Simple Circuits

We begin by constructing four simple circuits (see the *Simple Circuits* page). Learning to construct these circuits provides the basic knowledge and skills needed to complete future projects.

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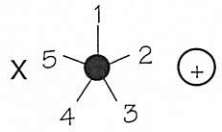
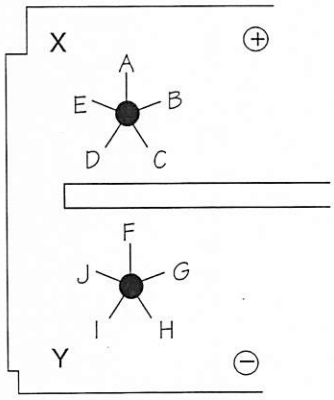
But first, we need to understand the layout of the solder-less breadboard. The row labeled X forms the top row. The top row of holes, in groups of five, are where the positive (+) connections from the power source (batteries) are made. Each hole in every group of five holes is connected to the other holes. Each group of five holes is a "junction" where five separate electronic devices can be connected. The same is true for the bottom row of holes labeled "Y."

Below the top row of holes are five more rows of holes labeled A, B, C, D, and E. The holes in each *column* of five holes are connected together. These five holes also form a junction.



A gap follows row E. The gap separates the top group of holes from the bottom group of holes. The top group is not connected to the bottom group. (In later projects, electronic "chips" will be used to bridge over this gap.)

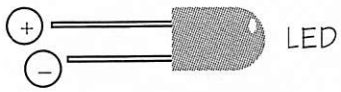
Below the gap are five more rows of holes. Again, the holes in each vertical column of five holes are connected together to form a junction.



The best way to learn how the holes are connected is to wire the *Light the LED* circuit found on the *Simple Circuits* page.

Wiring the *Light the LED* Circuit

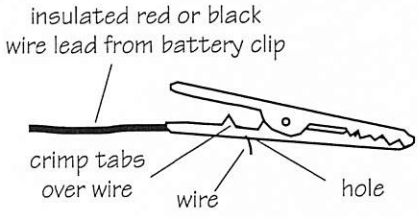
1. The shaded holes on the diagram show which holes are used to wire the circuit.
2. Cut a three-inch length of bell wire and strip a quarter-inch of insulation from each end. Insert one end in the left-most hole in row X. Do the same for the first hole in the Y row.
3. Cut and strip the ends of a short (two-inch) length of bell wire. Insert one end of the wire in the next shaded hole in row J. Do the same in row Y.
4. Insert the positive (longer) wire of the LED in the shaded hole on row E. Make sure this wire is in the shaded hole in the second column. Insert the short wire in the shaded hole on row F.



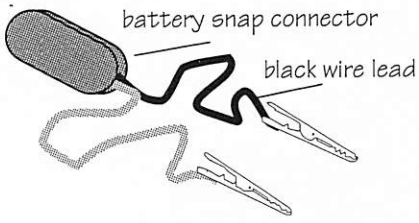
5. All that's needed now is to hook a power source to the circuit. Two 1.5-volt AA batteries connected in series provide the three volts required to light the LED.

Making the Battery Pack

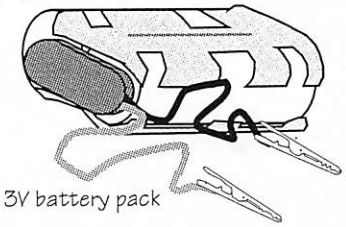
Take one of the heavy-duty 9-volt battery snap connectors and two mini-alligator clips. Slide a wire lead from the connector through the base and out the small hole in the bottom of a clip. Crimp the tabs over the insulated portion of the wire lead. This holds the clip tight but for added strength, solder the bare wire to the clip where it passes through the hole.



Repeat this for the other battery lead. Your finished battery snap connector should look like the one in this diagram.



Install two size AA batteries in the plastic battery pack and clip the battery snap connector to the top of the battery pack.



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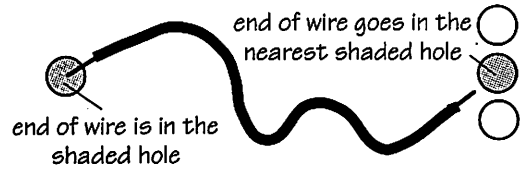
WARNING: Do not let the two alligator clips touch. If the clips touch, a short circuit exists that will generate a large amount of heat and quickly deplete the batteries. When the battery pack is not in use, attach one of the alligator clips to the insulation of the other clip or detach the snap connector from the battery pack.

Testing the *Light the LED* Circuit

1. Connect the red-wire alligator clip of the battery pack to the three-inch long wire in row X on the breadboard. Connect the black-wire to the three-inch long wire in row Y. The LED should light.
2. If the LED does not light, check each connection and that the circuit is wired as shown in the diagram on the *Simple Circuits* page.

Constructing the Series, Parallel, and Short Circuits

1. The three remaining circuits contain switches. Each switch is shown as a wire with one end in a shaded hole and the other end near a shaded hole.
2. The switches are shown on the diagrams as "open" switches. To close a switch, simply put the end of the switch wire in the shaded hole shown on the diagram.

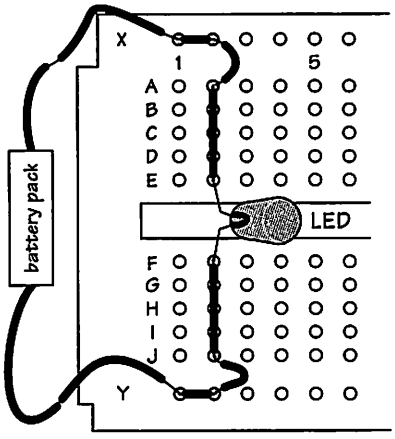


3. For the *Series Circuit*, note that *both* switches must be closed for the LED to light.
4. The LED will light in the *Parallel Circuit* when either (or both) of the two switches is closed.
5. In the *Short Circuit*, closing the switch allows the electrical current to bypass (take the path of least resistance) the LED. In this case, closing the switch turns the LED off, not on.

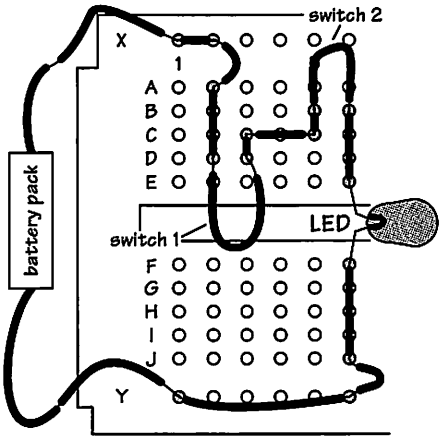
Complete Circuit Diagrams

The following diagrams show the complete circuits for each of the circuits that appear on the *Simple Circuits* page. The diagrams help show the path the electrical current takes in each circuit. If students construct the circuits, it's a good idea to have them use a crayon or marker to trace the path of each circuit on the diagrams.

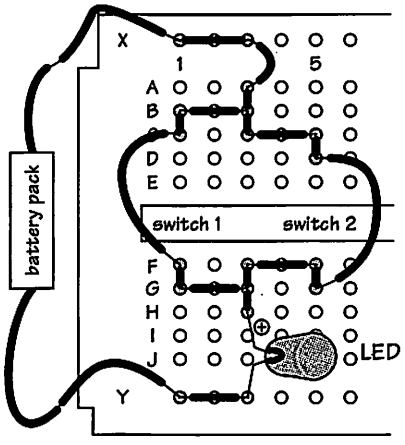
Light the LED



The *Series* circuit diagram. This circuit is equivalent to the series circuit found in "batteries and bulbs" units. Both switches must be closed for the LED to light.



The *Parallel* circuit diagram. This circuit is also equivalent to the parallel circuit found in "batteries and bulbs" units. Only one (or both) of the two switches has to be closed for the LED to light.



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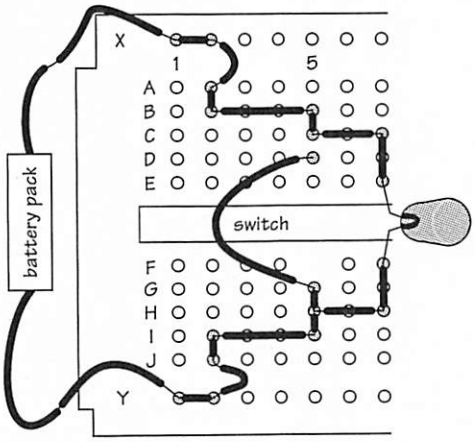
Closing the switch in *Short Circuit* provides an alternate path for the electrical current to follow. This alternative path contains less resistance to the flow of electrical current (there's no LED to slow down the current) which is why this path is called "the path of least resistance."



These breadboard circuits are also alternative ways to build the circuits described in the *Tinkering* columns found in Volume XV, Number 2; Volume XV, Number V; and Volume XVI, Number 6.

In traditional "electricity" programs, students connect two or more flashlight bulbs, not switches, in series and parallel. In electronic circuits, it's switches (transistors) that are connected in series, parallel, and combinations of the two. That's the basic difference between a string of Christmas lights and a computer. As this series of projects develops, this difference will be made increasingly apparent.

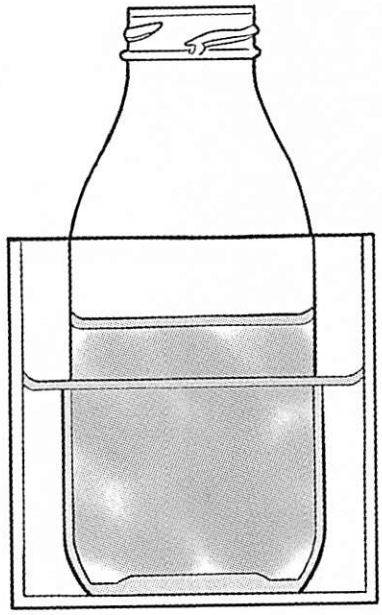
Mark Twain's famous short story, *The Notorious Jumping Frog of Calaveras County,* inspires the next column. A simple paper frog, folded from a business card, will teach and amuse us.

(INVISIBLE, cont. from page 30.)

4. Place the bottle in the container and observe it carefully. Note that the glass sides are clearly visible.
5. Discuss this phenomenon.

Extensions

1. Repeat this process with a variety of different bottles.
2. Repeat the activity with plain, instead of colored, water. Note any differences.
3. Use colored water in the container and clear liquid in the bottle and note any differences. Then add food coloring to the water in the bottle and see what happens.



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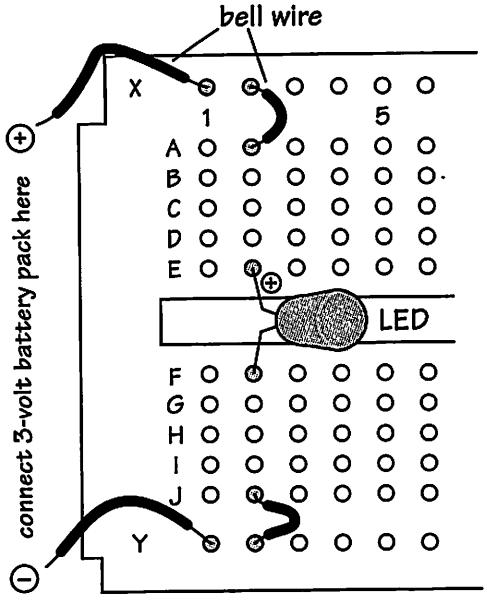
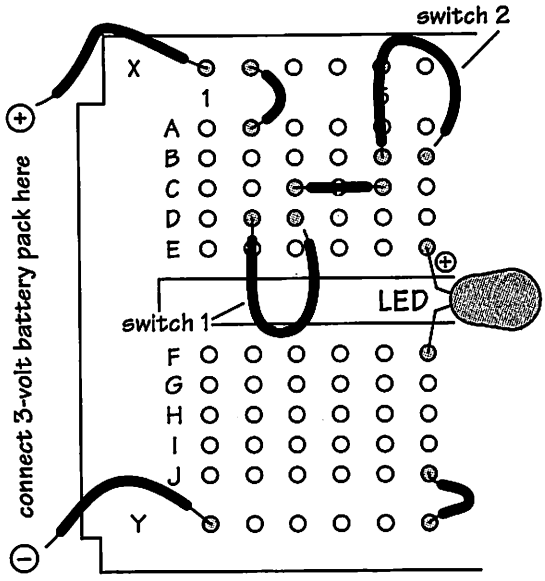
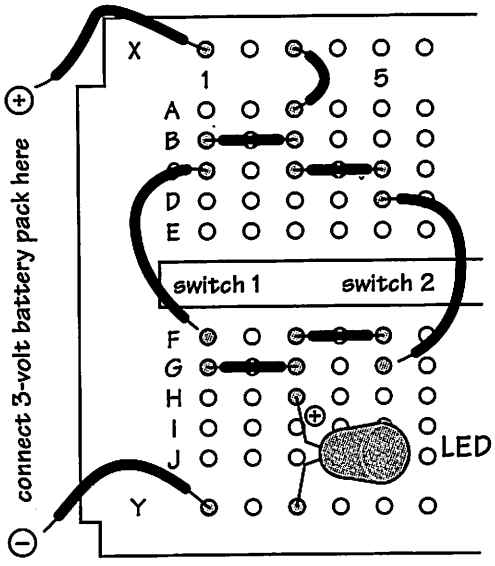
Simple Circuits



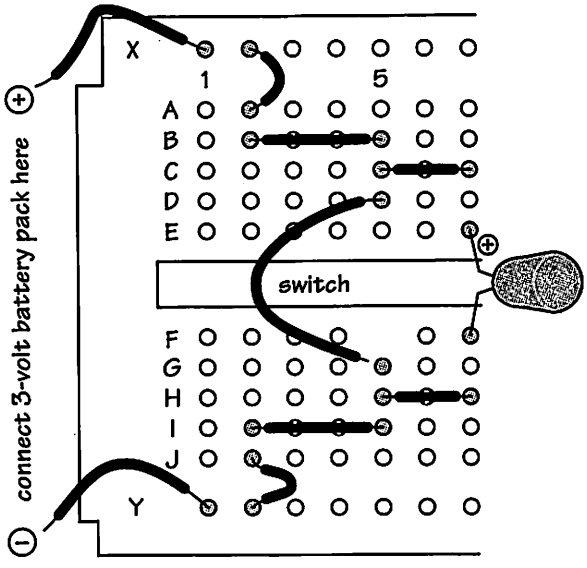
Light the LED



Series Circuit



Parallel Circuit



Short Circuit

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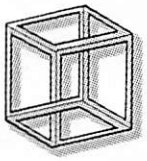


Puzzle Corner

Uniquely Even

by Michelle Pauls

In this month's *Puzzle Corner* activity, students are challenged to find multiple solutions to a problem, organize those solutions in a logical manner, and justify why they think they have found all possible solutions. There are two versions of the same problem presented, with differing numbers of solutions.

To begin, students will each need a copy of the first two student pages and 12 small objects which will fit into the squares on the first student page. Area tiles, math chips, beans, buttons, pennies, etc. will all work well. The object of the puzzles is to arrange either 10 or 12 objects in the 4 x 4 grid in such a way that every row, column, and long diagonal has an even number of objects.

As students find solutions, they should record them on the solutions page. Emphasis should be placed on only recording unique solutions. This will require students to exercise their spatial skills as they consider whether or not a given solution is different from those already discovered even when flipped and/or rotated.

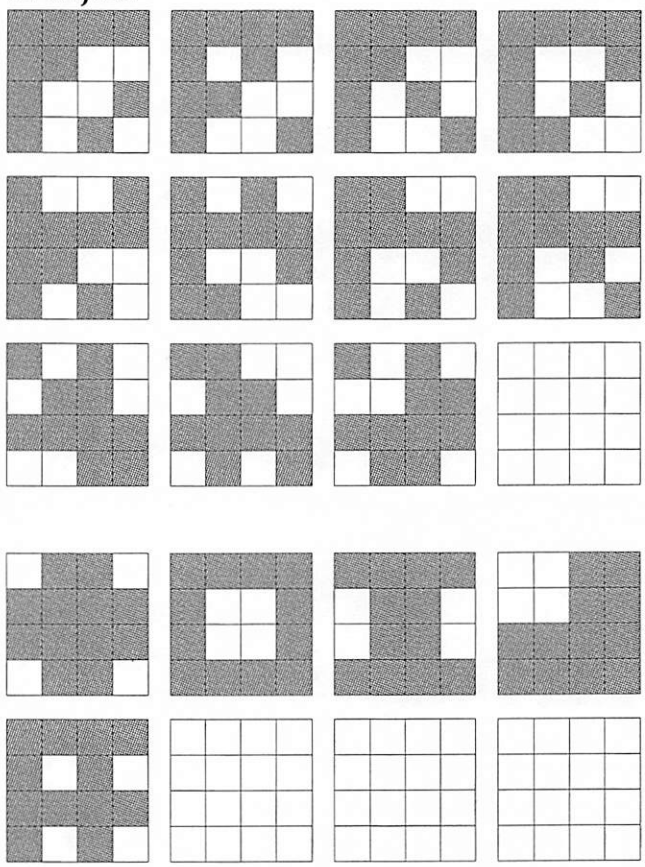
Once students feel that they have discovered all the possible solutions for each version of the puzzle, distribute another copy of the solutions page as well as the third student sheet. Encourage students to carefully consider how they would like to organize their solutions and accurately describe their methods.

When all students have organized their solutions, have a time of class discussion in which students share all the solutions they discovered. As a class, develop a master list of unique solutions and try to determine if all possible solutions have been discovered. Discuss any patterns that can be seen in the solutions and how these might help determine if all possible solutions have been discovered.

I hope you and your students enjoy this problem. The solutions will appear with next month's puzzle, but if you need them before then, feel free to contact me at meyoungs@fresno.edu.

Solutions

10 objects



April's Puzzle

Oops! We forgot to publish the solutions to the April Puzzlers, so here they are.

1. *Why are 2002 pennies worth more than twenty dollars?*
   Two thousand and two pennies are equal to $20.02.
2. *Juanita's grandmother is only five years older than her mother. How is this possible?*
   Her grandmother is her dad's mother.
3. *Mr. Jones and his son Greg were in a terrible automobile accident. Mr. Jones died at the scene, but Greg was rushed to the hospital in critical condition. When the ambulance arrived at the emergency room, the surgeon took one look at Greg and said, "I can't operate on this boy, he's my son." How do you explain this?*
   The surgeon is Greg's mother.
4. *The trip up to the mountains took an hour and twenty minutes, but the trip back down only took eighty minutes. How come?*
   One hour and twenty minutes is equal to 80 minutes.
5. *Farmer Fran has four white sheep, three black sheep, and one brown sheep at her farm. How many sheep can say they are the same color as another sheep at the farm?*
   None, sheep can't talk.

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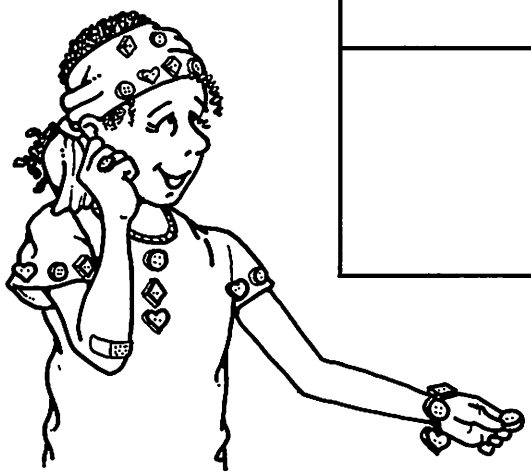
Uniquely Even

Part One

Place 12 objects into the squares below so that each row, column, and long diagonal has an even number of objects. Record each unique solution that you find in the spaces on the following page. A unique solution is one that is different from others even when it is flipped and/or rotated.



Part Two

Place 10 objects in the square above so that each row, column, and long diagonal has an even number of objects. Record each solution that you find in the spaces on the following page. A unique solution is one that is different from others even when it is flipped and/or rotated.

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Uniquely Even

Record your solutions in the spaces below.

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Uniquely Even

Answer these questions once you think you have discovered every possible solution for both parts of the problem.

1. Using a second copy of the solutions page, organize your solutions to each problem in a logical manner. Describe the method of organizing you used.

2. Look at your solutions. Describe any patterns that you see.

3. Now that you have organized your solutions, do you think you have found them all? Why or why not?

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Maximizing Math
Rules of Arrangement
by Michelle Pauls

This month's *Maximizing Math* activity is the first in a two-part series. The next installment will appear in the October issue. Both of these activities have students explore patterning in a variety of ways with an emphasis on problem solving and multiple solutions. The context for the patterns is a variety of regular and irregular geometric shapes having three, four, five, or six sides. This makes these activities ripe for geometry extensions studying the properties and attributes of shapes.

In this first installment of the activity, students will cut out a set of 16 shapes, and then explore these shapes by sorting them in a variety of ways. Once they have thoroughly explored the shapes, they will move on to a series of pattern explorations.

To begin, distribute the first student sheet and scissors to each student. This first student page should be copied onto card stock for durability. Have students cut out the 16 shapes and explore various ways to sort them. Encourage students to look at many different attributes of the shapes such as size, types of angles, number of sides, etc. Have a time of class discussion in which students can share the observations they have made about the shapes. Students should discover that there are four different kinds of shapes: triangles, quadrilaterals, pentagons, and hexagons. There are also four different fills: solid, speckles, scales, and circles/dots. There is one of each shape with each fill. Some of the shapes are regular, while some are irregular.

Once this time of exploration and discussion is completed, students will be ready to move on to the second portion of the activity. Distribute the second and third student sheets and go over the instructions with the class. Students are presented with a series of three shapes and challenged to identify three different patterns, or rules, that could define the sequence. They are then challenged to determine which of their remaining shapes could come next in the sequence given each of these rules.

It is important that students are aware of all the attributes that can form the basis for patterns. Attributes include the relative size of the shapes, the fill of the shapes (solid, speckled, scaled, dotted), the kind of shape (triangle, quadrilateral, pentagon, hexagon), whether there is an odd or even number of sides, whether there are acute, right, or obtuse angles, and so on. Encourage creativity as students identify possible rules. It is also important that students understand that the pattern must repeat after four shapes. It may repeat in fewer than four, but may not be longer than four. The tables below give several examples of usable and unusable patterns.

Examples of usable patterns

Repeats after two	odd sides, even sides, odd sides, even sides...
Repeats after three	solid, dotted, speckled, solid, dotted, speckled...
Repeats after four	hexagon, pentagon, quadrilateral, triangle, hexagon, pentagon, quadrilateral, triangle...

Examples of unusable patterns

Repeats after five	solid, dotted, scaled, scaled, speckled, solid, dotted, scaled, scaled, speckled...
Repeats after six	triangle, quadrilateral, pentagon, pentagon, hexagon, pentagon, triangle, quadrilateral, pentagon, pentagon, hexagon, pentagon...

Once students have completed these two pages, they will be ready to move on to the final section where they create their own sequence of three shapes to be traded with a classmate. Students should trace around the shapes they have chosen and do their best to draw the appropriate fill in each. They should then trade papers with a classmate and find rules for each other's patterns. Close with a time of class discussion where students share about the patterns they developed and the things they learned from this activity.

Be sure to have students save their shapes for next month's activity, a fun and challenging game which builds on the pattern-making and problem-solving skills students developed in this activity. If you have any questions or comments about this activity, please feel free to contact me at AIMS.

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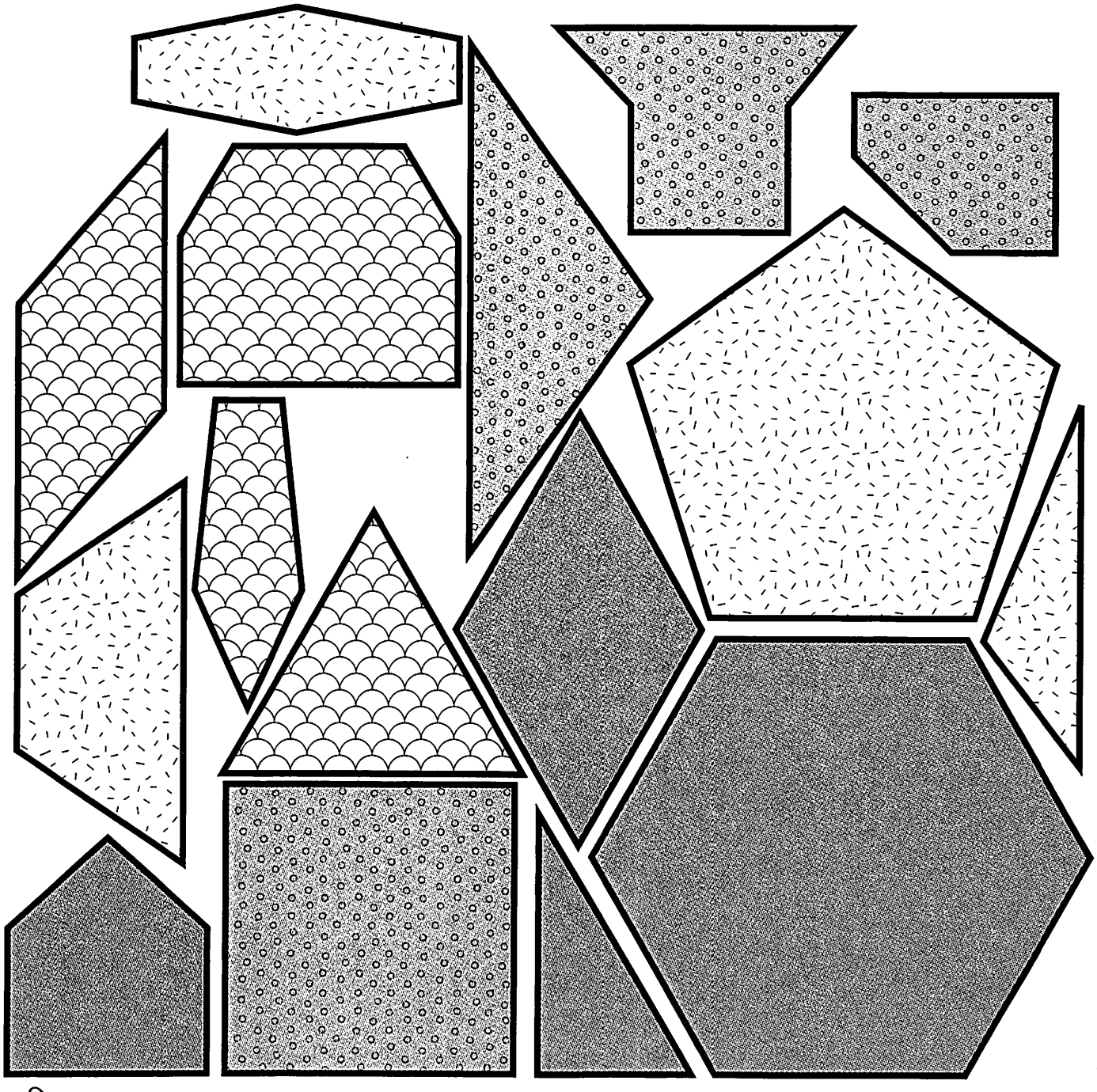
RULES OF ARRANGEMENT

Carefully cut out the shapes below. Sort them in at least three different ways. Record the results of each sort and describe the set of shapes as completely as you can. How many shapes are there? What kinds of shapes are there? How many fills are there? How many shapes are there with each fill? What kinds of shapes have each fill?



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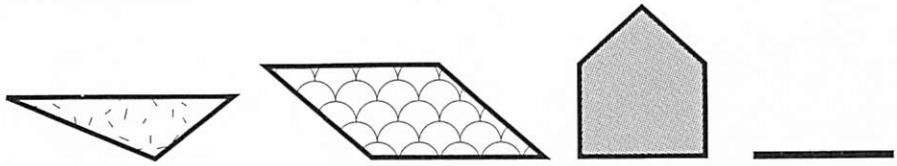
RULES OF ARRANGEMENT

In the sequences below and on the next page, there are several possible ways to continue the patterns using only the shapes you cut out. Find three different rules which could describe the patterns and list all of the possible next shapes based on those rules. Use the spaces provided to record the rules and write or draw all of the possible next shapes. Part of one problem has been done for you as an example.



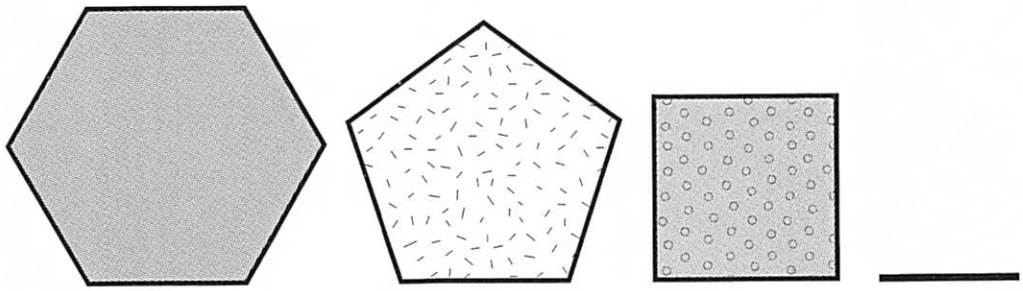
Rule #1: The rule is shapes: triangle, quadrilateral, pentagon, hexagon

Possible next shapes: Solid, speckled, scaled, or dotted hexagon

Rule #2: The rule is fills: speckles, scales, solid, speckles, scales, solid

Possible next shapes: Speckled quadrilateral, pentagon, or hexagon

1.



Rule #1: _____

Possible next shapes: _____

Rule #2: _____

Possible next shapes: _____

Rule #3: _____

Possible next shapes: _____

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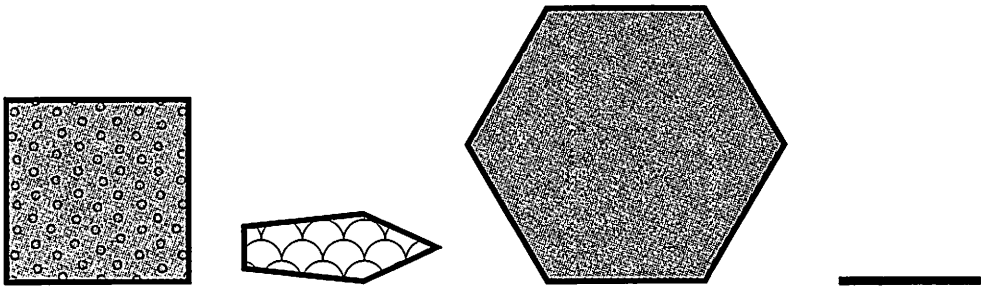
RULES OF ARRANGEMENT

2. 

Rule #1: _____

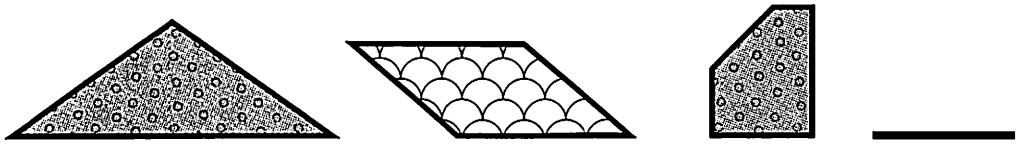
Possible next shapes: _____

Rule #2: _____

Possible next shapes: _____

Rule #3: _____

Possible next shapes: _____

3. 

Rule #1: _____

Possible next shapes: _____

Rule #2: _____

Possible next shapes: _____

Rule #3: _____

Possible next shapes: _____

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RULES OF ARRANGEMENT

Use this page to create your own three-shape pattern that can be extended in at least three different ways. Illustrate your pattern by tracing around the shapes you have chosen and giving them the appropriate fill. Trade your paper with a classmate and have him/her find three different rules that could describe your pattern.

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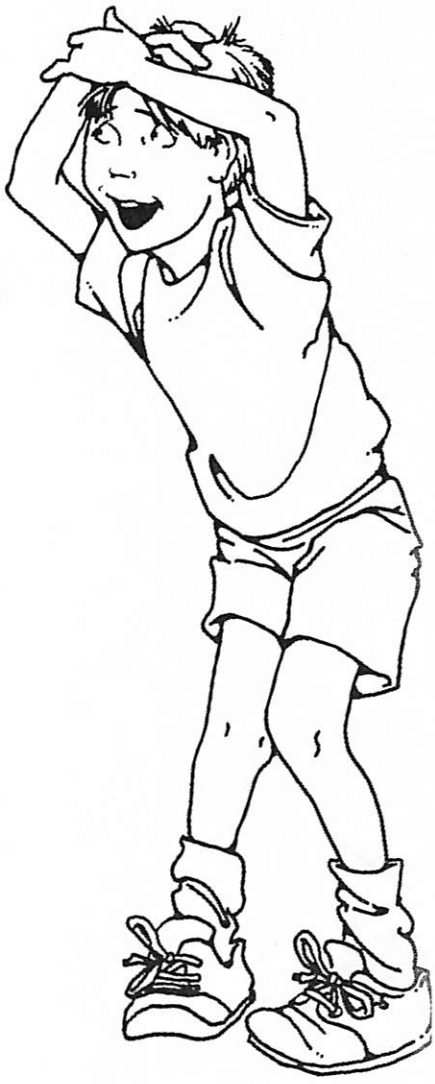

Alabama

11/12	Mobile	AL	Marvelous Multiplication and Dazzling Division, 4-5
11/13	Mobile	AL	Awesome Addition and Super Subtraction, 2-3

California

11/5	Anaheim	CA	Notable Numbers, K-1
11/6	Anaheim	CA	Awesome Addition and Super Subtraction, 2-3
11/14	Anaheim	CA	Marvelous Multiplication and Dazzling Division, 4-5
10/10	Burbank	CA	Marvelous Multiplication and Dazzling Division, 4-5
10/22	Burbank	CA	Notable Numbers, K-1
10/23	Burbank	CA	Awesome Additional and Subtraction, 2-3
Super 10/9	Fresno	CA	Marvelous Multiplication and Dazzling Division, 4-5
10/15	Fresno	CA	Awesome Addition and Super Subtraction, 2-3
10/29	Fresno	CA	Proportional Reasoning, 6-8
11/5	Fresno	CA	Notable Numbers, K-1
11/5	Thousand Oaks	CA	Awesome Addition and Super Subtraction, 2-3
11/6	Thousand Oaks	CA	Marvelous Multiplication and Dazzling Division, 4-5

Florida

10/1	Altamonte Springs	FL	Awesome Addition and Super Subtraction, 2-3
10/2	Altamonte Springs	FL	Notable Numbers, K-1
10/8	Altamonte Springs	FL	Marvelous Multiplication and Dazzling Division, 4-5

Michigan

10/29	Romulus	MI	Awesome Addition and Super Subtraction, 2-3
11/7	Romulus	MI	Marvelous Multiplication and Dazzling Division, 4-5
11/13	Romulus	MI	Notable Numbers, K-1
10/29	University Center	MI	Awesome Addition and Super Subtraction, 2-3
10/30	University Center	MI	Notable Numbers, K-1
11/6	University Center	MI	Marvelous Multiplication and Dazzling Division, 4-5

Montana

11/7	Billings	MT	Marvelous Multiplication and Dazzling Division, 4-5
10/2	Great Falls	MT	Awesome Addition and Super Subtraction, 2-3
10/3	Great Falls	MT	Marvelous Multiplication and Dazzling Division, 4-5
10/22	Helena	MT	Awesome Addition and Super Subtraction, 2-3
10/23	Helena	MT	Marvelous Multiplication and Dazzling Division, 4-5
10/24	Helena	MT	Proportional Reasoning, 6-8
11/13	Missoula	MT	Awesome Addition and Super Subtraction, 2-3
11/14	Missoula	MT	Marvelous Multiplication and Dazzling Division, 4-5

North Carolina

10/10	Charlotte	NC	Marvelous Multiplication and Dazzling Division, 4-5
11/12	Charlotte	NC	Proportional Reasoning, 6-8
11/19	Charlotte	NC	Notable Numbers, K-1
11/20	Charlotte	NC	Awesome Addition and Super Subtraction, 2-3
10/8	Greenville	NC	Marvelous Multiplication and Dazzling Division, 4-5
10/22	New Bern	NC	Awesome Addition and Super Subtraction, 2-3
10/30	New Bern	NC	Marvelous Multiplication and Dazzling Division, 4-5
10/29	Raleigh	NC	Notable Numbers, K-1
10/30	Raleigh	NC	Awesome Addition and Super Subtraction, 2-3
11/7	Raleigh	NC	Proportional Reasoning, 6-8
11/13	Raleigh	NC	Marvelous Multiplication and Dazzling Division, 4-5

Oregon

10/17	Medford	OR	Marvelous Multiplication and Dazzling Division, 4-5
10/29	Oregon City	OR	Marvelous Multiplication and Dazzling Division, 4-5

South Carolina

10/8	Florence	SC	Marvelous Multiplication and Dazzling Division, 4-5
10/22	Florence	SC	Awesome Addition and Super Subtraction, 2-3
11/12	Florence	SC	Notable Numbers, K-1
10/9	Greenville	SC	Marvelous Multiplication and Dazzling Division, 4-5
10/24	Greenville	SC	Awesome Addition and Super Subtraction, 2-3
11/13	Greenville	SC	Notable Numbers, K-1
10/10	North Charleston	SC	Marvelous Multiplication and Dazzling Division, 4-5
10/23	North Charleston	SC	Awesome Addition and Super Subtraction, 2-3
11/14	North Charleston	SC	Notable Numbers, K-1

Tennesee

10/25	Chattanooga	TN	Notable Numbers, K-1
11/6	Chattanooga	TN	Magnificent Multiplication and Dazzling Division, 4-5
10/12	Franklin	TN	Awesome Addition and Super Subtraction, 2-3
11/9	Franklin	TN	Notable Numbers, K-1

Texas

10/12	El Paso	TX	Meaningful Measurement, K-2
10/19	El Paso	TX	Science TAKS, 3-5
10/19	Fort Worth	TX	Meaningful Measurement, K-2
10/26	Fort Worth	TX	Science TAKS, 3-5
10/19	Houston	TX	Science TAKS, 3-5
10/19	Houston	TX	Meaningful Measurement, K-2
10/19	Laredo	TX	Science TAKS, 3-5
10/26	Laredo	TX	Meaningful Measurement, K-2
10/12	Midland	TX	TAKS-Science, 3-5
10/26	Round Rock	TX	Meaningful Measurement, K-2
11/16	Round Rock	TX	Science TAKS, 3-5
10/26	San Antonio	TX	Science TAKS, 3-5
11/16	San Antonio	TX	Meaningful Measurement, K-2

Virginia

10/16	Harrisonburg	VA	Marvelous Multiplication and Dazzling Division, 4-5
11/6	Harrisonburg	VA	Awesome Addition and Super Subtraction, 2-3
10/16	Sandston/Richmond	VA	Marvelous Multiplication and Dazzling Division, 4-5
10/24	Sandston/Richmond	VA	Awesome Addition and Super Subtraction, 2-3
11/13	Sandston/Richmond	VA	Notable Numbers, K-1
11/14	South Hill	VA	Marvelous Multiplication and Dazzling Division, 4-5

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MAKING THE INVISIBLE, VISIBLE

by Dave Youngs

Acknowledgments

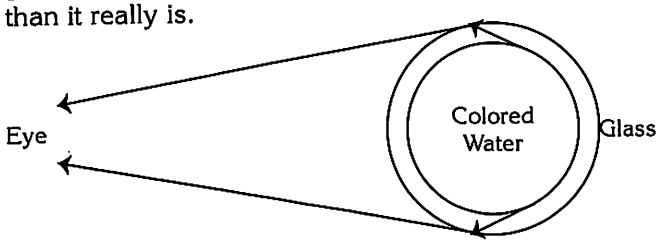
The idea for this activity came from a mind-boggling photograph in Paul Hewitt's textbook, *Conceptual Physics*. The photograph appears in the chapter on light refraction and shows two identical, unopened, old-fashioned, soda bottles side by side. One of these bottles is encased in solid plastic, while the other is not. (It is, however, "encased" in air.) The bottle in the clear plastic block appears to have much less soda than the bottle sitting next to it, even though they both contain the same amount. This strong visual paradox occurs because the plastic surrounding the one bottle makes visible its (normally) invisible glass sides.

Background Information

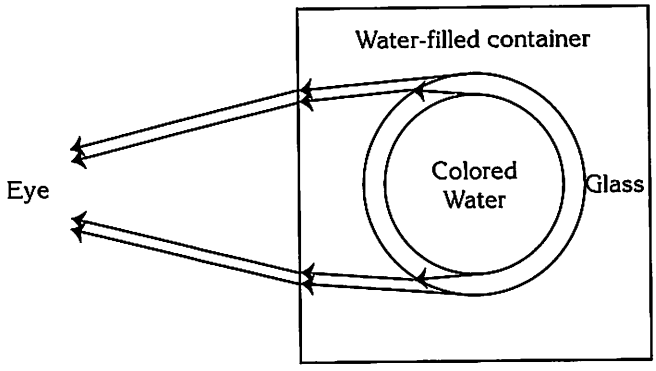
This activity models the above phenomenon using a glass bottle filled with colored water. When this bottle is viewed in the air, the colored liquid appears to completely fill it from side-to-side and the glass walls of the bottle are invisible. When the bottle is placed in water, its sides become clearly visible. Both of these phenomena are a result of *refraction*, the bending of light that occurs when light goes from one medium into another.

Light travels at different speeds through different transparent media. Its top speed of about 300,000 kilometers per *second* occurs in a vacuum. Its speed in air is only slightly less—about 99.97% of its top speed. Light travels significantly slower through things like water (about 75% of its top speed), glass (about 67% of its top speed), or other transparent media. This change in speed as it travels from one medium to another (air to glass, for example) causes light to bend or *refract*.

To see why refraction makes the colored water seem to fill the bottle from side-to-side, study the following diagram. The light rays coming from the edge of the colored water travel through the glass more slowly than they do through air. When they reach the air surrounding the bottle, they speed up. This speeding up causes these light rays to be bent toward the viewer's eye as illustrated below—thus making the glass walls disappear and the bottle appear more full than it really is.



When the bottle is placed in water, the glass sides become visible. This phenomenon is illustrated in the following diagram. In this instance, light rays from the colored water go through the glass, then speed up and bend slightly as they enter the water in the container. These rays (the inner rays in the diagram) travel on to the edge of the container. There, they bend again as they speed up upon entering the air surrounding the container. The rays from the edges of the bottle (outer rays shown below) travel in a straight line until they encounter the air. At this point they bend toward the eye as they speed up. These outer and inner rays delineate the glass sides and make them visible.



Materials

Clear glass bottle (the thicker the sides, the better)
Liter box or other transparent container big enough to hold the bottle
Food coloring

Management

1. While this activity will work with any glass bottle, it is much more dramatic with bottles that have thick sides. Old-fashioned soda or milk bottles are examples of some such bottles.
2. If a transparent container isn't available, an opaque one can be substituted. Students can view the bottle from above the edge of this container instead of through its sides.

Procedure

1. Fill the container with enough water so that it won't overflow when the bottle is immersed.
2. Fill the bottle with water and add a few drops of food coloring.
3. Carefully observe the bottle. Note that the liquid appears to go all the way to the sides of the bottle and that the glass sides of the bottle are not visible.

(See INVISIBLE, page 17.)

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Literature Links

by Myrna Mitchell

The Twizzlers Percentages Book

Jerry Pollotta, the author of *The Hershey's Fraction Book,* has done it again. He has found a way to motivate students to learn more about math in a fun and relaxed way. Your students will be excited to learn more about percentages when you use his newest book, *The Twizzlers Percentages Book* (Scholastic, Inc. New York. 2001.), to introduce percentage concepts. The book is bright and colorful, and of course uses Twizzlers licorice candy as the vehicle to introduce percentages.

Pollotta begins the book by showing 100 red licorice sticks and explains that 1/100, .01, and 1% are all equivalent ways of representing each licorice stick. He continues to emphasize the relationship between fractions, decimals, and percentages throughout the book. He also goes into a brief description of our base ten system and place value positions through the thousandth place.

By using a combination of both black and red licorice sticks, Pollotta is able to illustrate several fractional parts of the whole and vary the size of the group. For example, at one point he has four sticks of licorice, three red and one black, which he uses to illustrate fraction, decimal, and percentage concepts.

Using the motivating vehicle of licorice sticks, he also shows the division process students must follow to convert fractions to decimals. He has even included real-world examples where it would be necessary to know percentages, such as when calculating batting averages.

Overall, this book is a great addition to any unit on percentages. It will be necessary, however, for your students to be familiar with some basic terms such as *numerator*, *denominator*, and *simplified fractions*, since these terms are mentioned, but not developed in the text.

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Suggested Language Activities

- The book emphasizes the relationship among fractions, decimals, and percentages. Ask the students to identify real-world applications of fraction, decimals and percentages. For example fractions are used in cooking measurements, decimals are used to record money, and grades are recorded in percentages.
- Have students write a "How to" paragraph explaining how something works or how to work a particular type of math problem.
- Ask the students to identify a math concept that was difficult for them to conquer. Allow them to write a book similar to Jerry Pallotta's that makes the math fun and clearly teaches the process involved in solving a particular type of problem. For example the students may want to look at fractions using multi-colored candies or long division using pebbles, etc.
- Encourage your students to write a letter to Jerry Pallotta telling how his book helped them understand percentages. They may also have suggestions for math concepts that they would like him to address in future books.
- Tell the students to search through the newspaper or nightly news to find references to fractions, decimals, or percentages. Discuss the contexts that the different forms appear in. For example the stock market usually reports in decimal form, weather often reports precipitation in decimal or percentage form, etc.
- Encourage students to write a review of the book.
- Ask students to create a game, complete with instructions that will give children practice converting from fractions to decimals to percentages.
- Have the students do research on the author and create a time line of his life.

Suggested Math and Science Activities

- "What's the Point" (*Fabulous Fractions*)
- "From Fractions to Decimals" (*What's Next? Vol. 2*)
- "The Parade of Triplets" (*Proportional Reasoning*)
- "Fraction Dominoes/Decimal and Percent Dominoes" (*Proportional Reasoning*)
- "Show Me the Money" (*Fabulous Fractions*)
- "Between 0 and One" (*Fabulous Fractions*)
- "By Golly, By Gum!" (*Jaw Breakers & Heart Thumpers*)
- "Making Cents of Percents" (*Proportional Reasoning*)
- "Patterns in Equivalent Fractions" (*Proportional Reasoning*)
- Have the students keep an hourly record of their activities in a 24-hour period of time. Allow them to figure out what percentage of the day they slept, ate, watched television, etc.
- Require the students to calculate the batting averages for several baseball players.
- Ask the students to write several percentage word problems, exchange them with a partner and solve them.

Following this article you will find an activity that can be used with this book.

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AND THE SURVEY SAYS

by David and Myrna Mitchell

Topic
Data Organization

Key Question
How can you use a circle graph to show the results of a survey?

Learning Goals
Students will:
1. conduct a survey,
2. create a circle graph that displays the results of the survey, and
3. use a percentage necklace to construct a circle graph.

Guiding Documents
Project 2061 Benchmark
- *Geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories can be used to represent objects, events, and processes in the real world, although such representatives can never be exact in every detail.*

*NCTM Standards 2000**
- *Build and draw geometric objects*
- *Recognize and apply geometric ideas and relationships in areas outside the mathematics classroom, such as art, science, and everyday life*

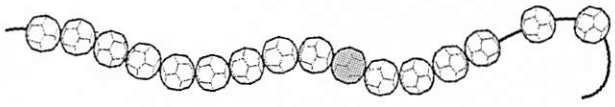
Math
Percentages
Data
tables and graphs

Integrated Processes
Observing
Communicating
Collecting and recording data
Interpreting data
Drawing conclusions

Materials
For each student:
10 green 8-mm faceted beads
90 clear 8-mm faceted beads
1 m of crochet thread
straight edge such as a ruler

Background Information
Surveys and graphs are a part of students' everyday lives. The focus of this activity is for the students to gather and graph the results of a survey that they themselves conduct. They will construct a device, a percentage necklace, which will help them easily divide a circle graph into sectors that will show results of the survey they conducted. Students will also see how percents and circle graphs are related. They will be able to clearly see that 100 percent is the entire circle, the whole. The necklaces then allow them to determine the percentages for the various responses.

Management
1. The 8-mm faceted beads can be purchased at craft stores or department stores. They are less expensive when purchased in large quantities.
2. The percentage necklace is constructed by stringing the 8-mm beads onto the crochet thread. The students will need to thread 9 clear 8-mm faceted beads for every 1 green 8-mm faceted bead. After all the beads are strung, the students will tie the ends of the string to form a necklace.



3. Direct the students to survey 10, 20, 25, or 50 people. These numbers will permit easy conversion when using the percentage necklace. The survey questions can connect to current events or things that are of high interest to the students. Encourage the students to select a survey topic that would give the opportunity for more than two responses. For example finding out people's favorite sports team.

Procedure
Part One
1. Ask the *Key Question* and state the first *Learning Goal.*

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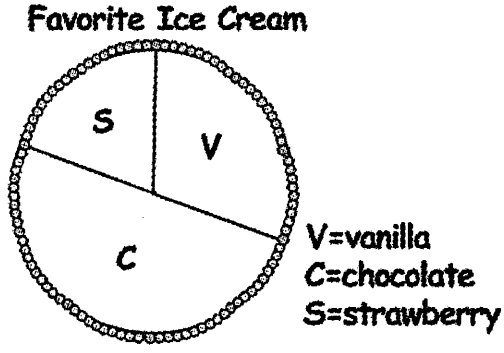
2. Tell the students that they will be conducting a survey. Challenge the students to select a topic that they would be interested in.
3. Distribute the first student page. Have them fill in the question that they will be asking. Direct the students to circle the number of people they will be surveying. Demonstrate, if necessary, how to keep ticks and tallies to show the responses.
4. Allow the students time to conduct their survey.

Part Two

1. Ask the *Key Question* and state the second and third *Learning Goals.*
2. Distribute the two different color beads to each student and demonstrate how they are to construct the percentage necklace.
3. Ask the students to get their completed survey collection sheets. Check to make sure they have organized the data.
4. Distribute the blank circle graph, show the students how they can use the necklace to form a circle with the beads on the outside of the blank circle graph.
5. Direct the students to determine the value of each of the beads in the necklace as it relates to the circle and the number of people they surveyed. (If the students surveyed 10 people, it takes 10 beads (100/10) to represent each person. If they surveyed 50 people, it takes two beads (100/50) to represent each person.)
6. Point out the midpoint on the blank circle graph. Direct the student to draw one radius from the midpoint to the edge of the circle using a straight edge. Show them how to align one of the colored beads with this radius. This will be the starting point from which they will construct the circle graph. If students surveyed ten people and they had three different responses, the graph would be divided into three different sectors. For example the students could survey favorite types of ice cream. Say that three people surveyed responded vanilla, five people said chocolate, and two people said strawberry. Three colored beads over from the starting radius a second radius would be drawn. A third radius would be drawn five additional colored beads over from the second radius. This divides the circle graph into three sections that would show the results of this survey.



7. Allow time for students to construct their circle graph for their survey.

Connecting Learning

1. What are the important parts of a circle graph?
2. How did the percentage necklace help with constructing the sectors of the circle graph?
3. How did you determine how many beads each response in the survey was worth?
4. How do circle graphs help us understand the results of a survey? [Circle graphs help us see part to whole relationships.]
5. Why is it important to know how many total people were surveyed when looking at the results of a circle graph? [A 30 percent sector that represents 300 people is not the same as a 30 percent sector that represents 3 people.]

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AND THE SURVEY SAYS

My question:

Number of people I will ask:

10 20 25 50

(Circle one)

Collect and organize your data below.

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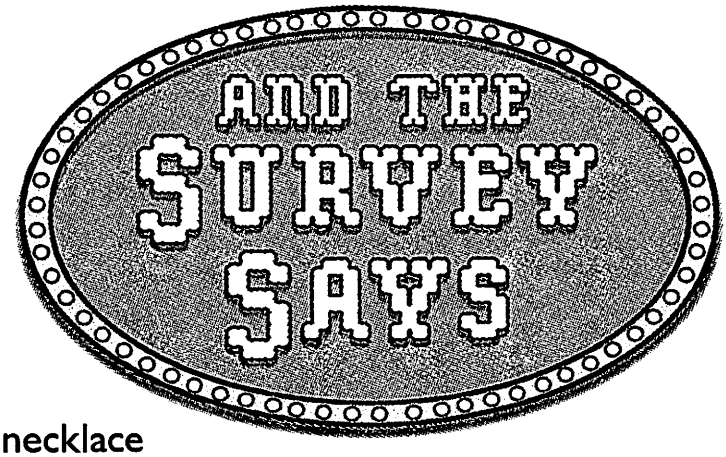

Use your percent necklace to make a circle graph of your data.

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List four things your data tell you.

Write the percentages for your results.

Explain how the percentage necklace helped you solve these problems.

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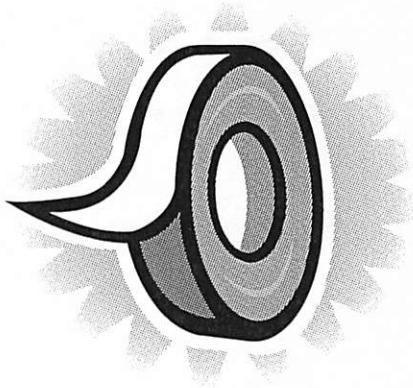
The Teachable Moment

by Suzy Gazlay

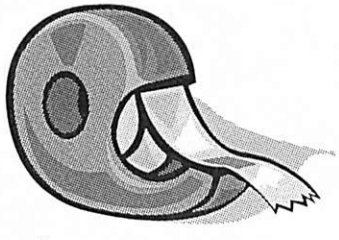


Transparent Tape

Among the basic supplies found in most American homes, classrooms, and offices, there is almost certain to be a roll of transparent tape. It might be held in a disposable plastic holder or installed in a fancy desktop dispenser. It might actually be translucent rather than transparent. It could be any of several choices of widths. Whatever the brand or packaging, the unpretentious roll of transparent tape has become indispensable for attaching, securing, repairing, creating, and applying to dozens of different situations.

As is so often the case, the inventor of transparent tape was actually working on something else when the idea hit. People who knew the inventor, Richard Drew, probably weren't surprised. Beginning when he was quite young, Drew was known for his curiosity and creativity. He loved taking things apart to see how they worked, and he was also quite good at putting them back together. He was not afraid to find out what would happen if he tried something. This willingness to take risks and think about things in a different way lasted throughout his entire life. He described himself as "more of a cook than a chemist," referring to the way that he stirred things up until he got results.

Richard Drew was a banjo player when the 3M company in Minnesota hired him in 1923. At that time, 3M was a small company that manufactured sandpaper. Richard happened to hear that auto painters were finding it very difficult to paint the line where the colors of a two-tone paint job met, frequently spoiling the paint job. For the next two years, he took on the challenge of solving this problem. The result was the invention of masking tape. The first version was a roll of two-inch wide tan paper with adhesive only along the edges. When the prototype was tried out, it fell off the car. The customer—an auto painter—was not impressed. He said that the bosses of 3M were "Scotch," meaning that they were thrifty to the point of being stingy, and told Richard to tell them to put more adhesive on the tape. The nickname "Scotch" stuck to the improved version of the masking tape.



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Meanwhile, an insulation company was looking for a way to seal the covering of insulation slabs used in railroad refrigerator cars. Another company, DuPont, had recently created a new material called *cellophane*, which became an immediate success in the food-processing business. Richard started thinking about the possibility of putting adhesive on cellophane to make a moisture-proof sealing tape that could withstand a wide range of temperature and humidity. He quickly found that the process used to make masking tape did not work on cellophane. The cellophane split easily in the machinery and curled when it got near heat. Furthermore, the adhesive wouldn't go on evenly. Richard persisted until he figured out a way to solve each of the problems. Still not satisfied, he kept working until he came up with a colorless adhesive made of rubber, oils, and resins so that the tape would look better.

Richard's boss had told him to quit working on the tape and get back to the sandpaper, but Richard was persistent and didn't obey. Fortunately the boss recognized the potential of Richard's creativity and decided to take a risk. On September 8, 1930, the new tape was ready to be marketed as "Scotch" tape. Scotch® is now a registered brand name belonging to the 3M company, but the name is commonly used to describe any transparent tape, no matter which company manufactures it.

By the time the new tape was ready to be marketed, the insulation company had lost interest. However, food industries were quite excited about the possibility of an attractive, moisture-proof means of sealing their new cellophane packages. The very first company to try out the new cellophane tape responded enthusiastically: "Put this product on the market!"

Even so, transparent tape got off to a slow start, with only $33 in sales the first year. To make things worse, a process was developed to heat-seal cellophane, eliminating the need for cellulose tape, at least for its original purpose. Many merchants preferred to keep using it anyway. This was during the time of the Great Depression, when most people had very little money to spend. Customers were inspired to find many creative and thrifty uses for the tape, far beyond the idea of packaging for which it was designed.

Anyone who has ever unwound too much tape and tried to get the excess neatly back on the roll has found that it's just about impossible. The process of making the tape is done completely by machine and is designed to avoid this problem. First the backing film and the adhesive are made separately. Large sheets of the backing film, several feet in width, are fed into a machine where a measured, very thin coating of adhesive is applied. The sheets are then dried in high temperature ovens and rolled on long tubes. The tube looks like a very wide roll of tape! It is moved through another machine where it is sliced into bands, depending upon the width of tape desired. The individual rolls are packaged and shipped to be sold.

Interesting Facts

- Transparent tape is available all around the world. More of it is sold than any other type of tape.
- Today over 900 different pressure-sensitive adhesives are made.
- Invisible transparent tape that can be written on became available in 1961.
- It didn't take long for customers to become frustrated with trying to find the end of a roll of tape. The first tape dispenser with a built-in cutter edge was marketed in 1935.

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- Designer Jean Reinecke spent 40 years thinking about the form and function of tape dispensers. His third design, which appeared in 1939, is the simple two-piece plastic holder still in use today. In 1953 he came up with the sturdy metal desk dispenser, also still in use.
- Creative thinkers have used transparent tape in many different ways, such as patching cracked eggs, repairing fingernails, mending clothes, and repairing cracks in walls. Some particularly noteworthy uses include:
  - ❖ To repair the torn covering on the rudder of a small airplane after cows nibbled off the fabric
  - ❖ As an anti-corrosive shield on the Goodyear Blimp
  - ❖ As a conveyor belt to move bullets along an assembly line in munitions plants during World War II
  - ❖ Also in World War II, to tape windows to prevent glass from flying during air raids. In England alone, more than 10 million yards of tape were used for this purpose.
- Like many other products, tape was not available to civilians during World War II. One manufacturer apologized for the shortage, reassuring the consumers that the tape would return when victory was won.
- At least ten new types of tape were developed during the war for military use.
- The process of developing cellophane tape included many failures. So much cellophane was spoiled sometimes that a truck was needed at the end of the day to cart it all away.
- Librarians, museum curators, and others who care for books and documents have learned the hard way not to use transparent tape for mending paper or parchment. The film part of the tape eventually gets brittle, and the chemicals in the adhesive leave a residue that is absorbed by the paper. The area once covered by tape will eventually become dry and break off. In order to salvage pages that have been taped, the residue must be chemically removed by means of a slow and painstaking process.
- The Dead Sea Scrolls are among the many documents that were "mended" with cellophane tape when it still was thought to be a good way to preserve and protect them.
- If the tape on one of those giant factory rolls were cut into half-inch rolls, and if all the tape on those rolls were joined together end to end, the tape would reach from Boston to Washington DC.

Things to Do

- Brainstorm and compile a list of possible uses for transparent tape.
- Survey the class to find their most recent specific uses of transparent tape. Organize the data and analyze for trends and unusual uses.
- Use the information on the packaging of several different brands of transparent tape to determine which is the best buy.
- Design an investigation to compare several different brands concerning such attributes as sticking power and how it holds up under tension.
- Compare the effectiveness of transparent tape to other common adhesives, such as white glue, glue sticks, duct tape, etc. Compile a list of which tasks would be best suited for each type of adhesive.
- Transparent tape is an excellent material for exploring and demonstrating some of the properties of static electricity. Note: this will not work well if the relative humidity is high. Also, some brands of tape work better than others.

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1. Darken the room and quickly peel some tape off the roll. If it is dark enough, you might be able to see a little spark.
2. Stick a long piece of tape on a painted metal surface such as a file cabinet. Place an AM radio near the tape. Tune it so that it is between two stations and all you can hear is static, then turn the volume up. Quickly peel the tape off the metal. The resulting static is picked up as radio waves, causing the static crackling noise you will hear from the radio.
3. Cut two strips of tape about 20 cm long. Hold each by one end and let them hang down. Have someone move a hand close to the strips. Slowly bring the two strips together, non-sticky sides facing each other. Try to make the two pieces of tape touch each other. Repeat with sticky sides facing in. Try again with a sticky side facing a non-sticky side.
4. Cut two more strips and fold 2-3 cm at one end of each to make a non-sticky flap. Put the two strips together so that the sticky side of one is stuck to the non-sticky side of the other. Grab the two flaps and use them to pull the strips apart quickly. Repeat the motions in #3 and compare.

- Do some research to learn more about Richard Drew, a creative and inspirational inventor who strongly believed that it isn't necessary to know everything in order to come up with something innovative: only to know enough to be able to start working on it, and not know enough to believe that it won't work.

Literature Connections

Books about inventions and innovative thinking (all 3rd grade and up):

Caney, Steven. *Steven Caney's Invention Book*. Workman Publishing Company. New York. 1985.

Egan, Lorraine Hopping. *Inventors and Inventions*. Scholastic, Inc. New York. 1999.

Jones, Charlotte Foltz. *Mistakes That Worked*. Doubleday. New York. 1994.

Reid, Struan, and Patricia Fara. *The Usborne Book of Inventors*. EDC Publications. Tulsa, OK. 1994.

Tucker, Tom. *Brainstorm!: The Stories of Twenty American Kid Inventors*. Farrar, Straus and Giroux. New York. 1995.

Internet Connections

Links to information about Richard Drew
http://inventors.about.com/library/inventors/blscotchtape.htm

Speech about Richard Drew and his innovation thinking, given at the annual Richard G. Drew Creativity Award ceremony in 1995.
http://mustang.coled.umn.edu/inventing/drewinvent.html

Sixty uses for scotch tape
http://www.3m.com/about3m/student/scotchbrand1/index.html

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Cool Conductors

by Dave Youngs

Topic
Heat conduction

Learning Goals
Students will:
1. explore and experience the conduction of heat energy using their sense of touch, and
2. classify materials as (heat) conductors or insulators.

Key Question
How can you use your sense of touch to determine which materials are good heat conductors and which ones are good insulators?

Guiding Documents
Project 2061 Benchmarks
- *When warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all at the same temperature. A warmer object can warm a cooler one by contact or at a distance.*
- *Some materials conduct heat much better than others. Poor conductors can reduce heat loss.*

NRC Standard
- *The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.*

Science
Physical science
heat conduction
conductors and insulators

Integrated Processes
Observing
Comparing and contrasting
Drawing conclusions

Materials
Activity sheet

Background Information
According to the second law of thermodynamics, heat energy flows naturally from hotter objects to cooler ones. When objects are in direct contact, this energy transfer occurs through the process called conduction. Some materials transfer heat energy more easily than others—these materials are called *conductors*. Materials that don't transfer heat energy well are called *insulators*.

When conducting materials are at room temperature, they feel quite cool to the touch since they quickly conduct heat energy away from our warmer bodies (which have a temperature of about 37 degrees Celsius, or 98.6 degrees Fahrenheit). Insulating materials at the same room temperature don't feel nearly as cool since they don't conduct heat energy well. Most of us experience this phenomenon in our homes when we walk barefoot from a carpeted area to a tiled area. The carpet is an excellent insulator and prevents body heat from being conducted away. The tile floor, however, is a good conductor and quickly conducts heat away. This makes the tile floor feel cooler than the carpet when in actuality they are both at the same room temperature.

In this activity students will use their senses of touch to determine which materials in their classroom are good conductors and which ones are good insulators—the conductors will feel noticeably cooler to the touch, even though they are really the same temperature as the insulators. To illustrate, the steel leg of a chair feels cool to the touch whereas the wood part of a pencil will not—steel is a good conductor, while wood is a good insulator. (Fortunately, air is an excellent insulator, otherwise we would always feel cold at room temperature.)

Management
1. This activity is meant to be done in the classroom. It works best when heating or cooling units are not in use. These units create different temperature zones within the classroom that are problematic.
2. Students will need to know the difference between objects and the materials making up the objects. For example, a pencil (object) is composed of many different materials (wood, rubber, graphite, etc.). If this distinction is not clear, discuss it beforehand.
3. Caution students not to include materials in their investigation that are not at room temperature—the plastic on the top of a running computer monitor, for example.
4. Ask students not to touch things they are testing for more than a few seconds. When conductors

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are in contact with warmer objects like students' hands, those objects quickly absorb enough heat energy to raise their temperatures above room temperature.

Procedure

1. Hand out the student sheet.
2. Ask the *Key Question: "How can you use your sense of touch to determine which materials are good heat conductors and which ones are good insulators?"*
3. Have students follow the directions on the student sheet. After they complete the activity, lead them in a class discussion.

Discussion

1. What did you notice when you touched your pencil and then the steel leg of your chair? [The steel felt cooler than the wood.]
2. What other materials did you touch?
3. Which ones felt cool?
4. Which ones didn't?
5. Are these different materials really different temperatures? [No.]
6. What temperature are they? [room temperature]
7. Why do some things feel cooler than others? [The materials that feel cooler are better conductors.]
8. What happens when you walk barefoot from a carpeted room to one with tile? [The tile feels cooler.]
9 Explain what happens in terms of what you've learned in this activity. [The carpet feels warmer than the tile since it doesn't conduct the heat away from your foot. In actuality, the carpet and tile are both at the same room temperature.]

Extensions

1. Have students investigate to see if different areas of skin feel the apparent temperature differences created by conduction better than others. Some areas to try are the side of the face, the neck, the back of the hand, and the arm.
2. Have students experience heat energy flowing into them instead of away from them by touching materials that are warmer than room temperature, (but not hot enough to burn!). Some things to try are their foreheads (which are often warmer than hands), the top of a running computer monitor, the sidewalk outside on a sunny day, or a metal tetherball pole in the sun.

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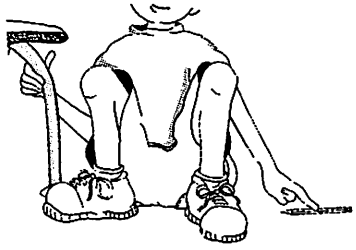
Cool Conductors

Using your sense of touch, how can you determine which materials are good heat conductors and which ones are good insulators?

Touch the wooden part of your pencil and then touch the steel leg of your chair. What do you notice? Which feels cooler to the touch, wood or steel?



Touch various other materials in the room. Which ones feel cool to the touch? Which ones don't? Make a list of these materials below.

Cool to the touch:

Not cool to the touch:

What similarities, if any, do you see in the above lists?

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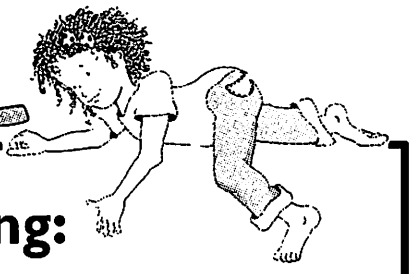
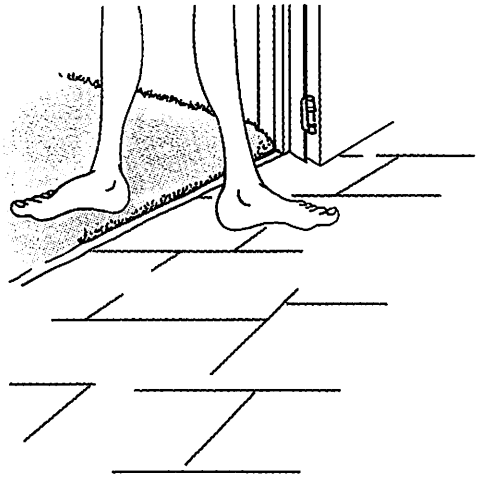
Cool Conductors



What's happening:

Scientists have learned that heat flows naturally from warmer things to cooler ones. Although the different materials in the room feel like they are at different temperatures, they are not. They are all about the same temperature, which we call room temperature. What makes some materials feel cooler than others is their ability to conduct heat away from your (warmer) body when you touch them. These materials are called conductors since they conduct or transfer heat well. The materials that don't conduct heat as well are called insulators. These materials don't feel as cool to the touch.

Now, think about what happens when you walk barefoot from a room with carpet to a room with tile. Explain what happens in terms of what you've learned in this activity.



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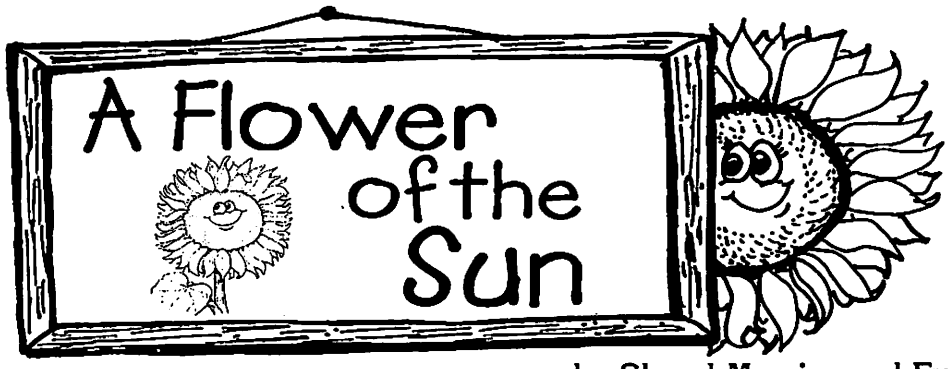

by Sheryl Mercier and Evalyn Hoover

Topic
Sunflower seeds

Key Question
What can we learn about sunflower seeds using our senses and math and science tools?

Learning Goals
Students will:
1. make careful observations of a sunflower head, and
2. use their senses and science tools to observe the physical properties of sunflower seeds.

Guiding Documents
Project 2061 Benchmark
- *People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.*

NRC Standards
- *Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.*
- *Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.*

*NCTM Standards 2000**
- *Measure with multiple copies of units of the same size, such as paper clips laid end to end*
- *Use tools to measure*
- *Understand how to measure using nonstandard and standard units*
- *Count with understanding and recognize "how many" in sets of objects*

Math
Measurement

Science
Life science
seeds

Integrated Processes
Observing
Predicting
Collecting and recording data
Comparing and contrasting

Materials
For Station 1: Observe
a sunflower head (or illustration of sunflower)
sunflower measuring tape

For Station 2: Explore a Seed
a small bag of unshelled seeds
hand lens

For Station 3: Estimate and Count
portion cup of sunflower seeds
2 class graphs (to be left at station)
2 different colors of pen

For Station 4: Balancing
cupful of unshelled sunflower seeds (at least 65)
2 Teddy Bear Counters
balance
cupful of shelled sunflower seeds

For Station 5: Pick up seeds
bowl of sunflower seeds

For Station 6: Sink or Float
10 sunflower seeds
bowl of water
paper towels

Background Information
The sunflower is a tall plant known for its showy yellow flowers. The flower heads are composed of many small tubular flowers arranged compactly on a flattish disk and surrounded by a fringe of large yellow petals. These flower heads can be 12 inches in diameter and produce up to 1000 seeds.

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When the sunflower head shrivels and the seeds are ripe, the plants are cut at ground level and stood with the head uppermost like corn shocks. When the heads are dry, the seeds are removed by hammering them out with a mallet. Then the seeds are stored in bags in a dry place.

(For more information, see *Reaching up to the Sun* in the July/August 2002 issue of *AIMS*®.)

Management

1. These activities are best done in small groups. Form about six groups within your class to rotate through the stations.
2. If possible, have a mature sunflower head that has ripe seeds ready to harvest. If a sunflower head is not available, use a drawing or photograph of the sunflower. Craft stores often carry silk replicas of sunflowers that can be used for measurement of petals and head.
3. Make and assemble the journals in which students can record their answers. Each student will need a journal.
4. Copy and assemble two sunflower measuring tapes. Place them at Station 1.
5. Place two copies of the class graph at Station 5 so all groups can record their data. One copy will be used to record estimations. Label the top of the graph with the word *Estimation.* The other copy will record actual counts. Label the top of this graph with the words *Actual Counts.*
6. Copy and laminate a set of station cards to be placed at the corresponding stations.

Procedure

1. Ask the students what they know about sunflowers, where have they seen them growing, and if they know how they grow. Record their answers on the board or a huge sunflower-shaped chart.
2. Ask how many students have eaten sunflower seeds. Allow time for tasting, if appropriate.
3. If a mature sunflower is available, show it to the class and talk about the various parts of the plant. (There are some artificial sunflowers that can be used or use a photograph of a mature sunflower.) Discuss how the seeds are formed in the flower head and how they are harvested.
4. Show the students a bag of sunflower seeds. Ask them, "Now that we know where sunflower seeds come from, what can we learn about the seeds?" Inform them that they will be using science and math tools to make observations.
5. Tell the students that they will be doing several activities at different stations that will allow them to observe and investigate sunflower seeds. Instruct them to record their answers in their journals.

Station 1

Observe

1. Look at the sunflower head.
2. Record your observations in your journal.

Station 2

Explore a Seed

1. Take a seed from out of the bag.
2. Draw a picture of your seed.
3. Record what you see, smell, feel, and hear. (Have hand lens or microscope available for use.)
4. Put your group's seeds in a pile.
5. See if a group member can find your seed from your description.

Station 3

Estimate and Count

1. Estimate how many seeds are in the cup. Record this amount.
2. Graph your estimation data in your journal.
3. Decide on a group estimation to add to the class graph.
4. Count the number of seeds in the cup. Record the actual number in your journal. Add the actual count to the graph in your journal.
5. Graph the actual count on the class graph.

Station 4

Balancing

1. Estimate and record in your journals how many sunflower seeds it would take to balance two Teddy Bear Counters.
2. Put the two Teddy Bear Counters in one pan of the balance. In the other pan, add and count how many sunflower seeds it takes to balance the bears. Record this in your journal.
3. Now estimate how many *shelled* sunflower seeds it will take to balance the two bears. Record your estimate in your journal.
4. Find out how many shelled sunflower seeds are actually needed. Write this number in your journal.
5. Find the difference between the number of unshelled and shelled seeds.

Station 5

Pick up Seeds

1. Estimate how many seeds you can grab in one handful. Record your estimates in your journal.
2. Grab a handful of seeds, count them, and record the results in your journal.
3. Color in the number of seeds you grabbed.

Station 6

Sink or Float

1. Predict whether 10 unshelled sunflower seeds will float or sink when you put them in water. Record your prediction in your journal.

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2. Put the seeds in the water. Record what happens.
3. Now shell the 10 seeds.
4. Predict whether the shelled seeds will float or sink. Record your prediction
5. Put the shelled seeds in the water and record what happens.

Discussion

1. Describe a sunflower seed, include its color, size, and how it feels.
2. How many seeds were you able to hold in one hand? Why do you think you were able to hold quite a few sunflower seeds in one hand?
3. Did the sunflower seeds float? Why do you feel the seed floated?
4. How many seeds did it take to balance one Teddy Bear? ...two Teddy Bears? Why was there a difference in each group?
5. What did you measure with your measuring tool and sunflower seeds? Do you feel the measurement was accurate? Why or why not?
6. Describe a sunflower and where the seeds are located.
7. What pattern did the seeds make on the sunflower head? Have you seen this pattern anywhere else?
8. What tools did your use to observe the sunflower? How did they help you make better observations?
9. What other things are you wondering about the sunflower seeds?

Extension

Prepare some sunflower seeds for roasting. Put into a large pot and cover the unshelled seeds with salted water (2 qts. of water to 1/2 cup salt). Bring to a boil and simmer two hours, or soak in a salt solution overnight. Drain and dry on absorbent paper.

Spread the seeds out in a shallow pan and put into a 300 degree F oven for 30 to 40 minutes or until browned. Stir occasionally. Take out of oven and add one teaspoon of melted butter to one cup of seeds. Stir to coat. Put on an absorbent towel. Salt to taste.

Evidence of Learning

Look for accurate descriptions of the sunflower seeds and the sunflower head. Evidence can be obtained through the students' journals and/or by listening as they share their observations.

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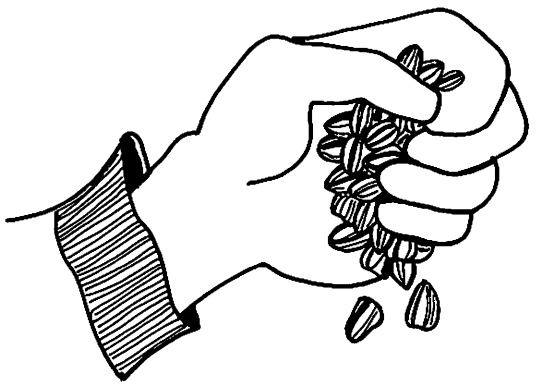
Station 3

Estimate and Count

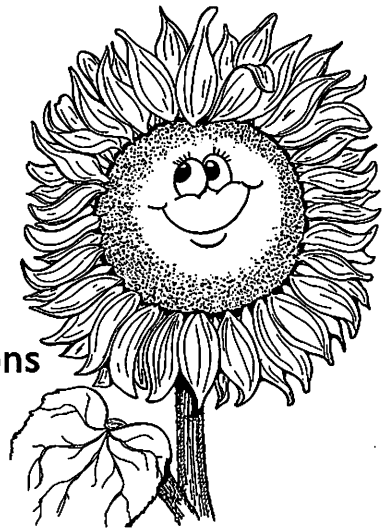
1. Estimate how many seeds are in the cup. Record this amount.
2. Graph your estimation data in your journal.
3. Decide on a group estimation to put on the class graph.
4. Count the number of seeds in the cup. Record the actual number in your journal. Add the actual count to the graph in your journal.
5. Graph the actual count on the class graph.



Station 1

Observe

1. Look at the sunflower head.
2. Record your observations in your journal.



Station 2

Explore a Seed

1. Take a seed from out of the bag.
2. Draw a picture of your seed.
3. Record what you see, smell, feel, and hear.
4. Put your group's seeds in a pile.
5. See if a group member can find your seed from your description.

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Station 4

Balancing

1. Estimate and record in your journals how many sunflower seeds it would take to balance two Teddy Bear Counters.
2. Put the two Teddy Bear Counters in one pan of the balance. In the other pan, add and count how many sunflower seeds it takes to balance the bears. Record this in your journal.
3. Now estimate how many shelled sunflower seeds it will take to balance the two bears. Record your estimate in your journal.
4. Find out how many shelled sunflower seeds are actually needed. Write this number in your journal.
5. Find the difference between the number of unshelled and shelled seeds.

Station 5

Pick up Seeds

1. Estimate how many seeds you can grab in one handful. Record your estimates in your journal.
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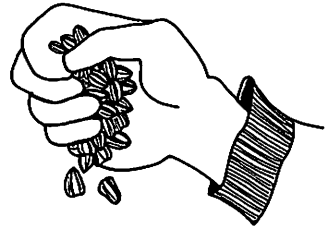

Station 6

Sink or Float?

1. Predict whether 10 unshelled sunflower seeds will float or sink when you put them in water. Record your prediction in your journal.
2. Put the seeds in the water. Record what happens.
3. Predict and record whether the shelled seeds will float or sink.
4. Put the shelled seeds in the water and record what happens.

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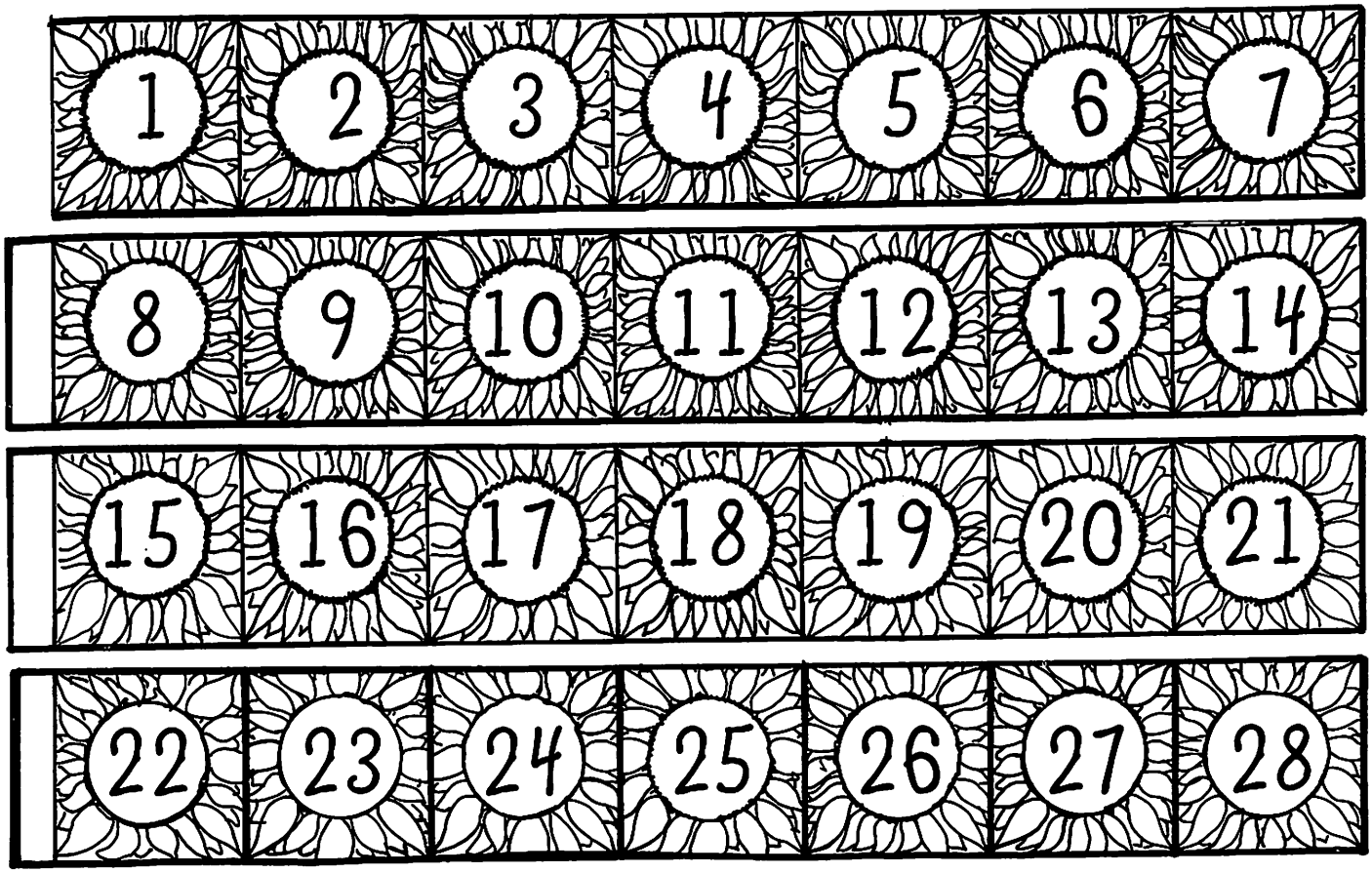

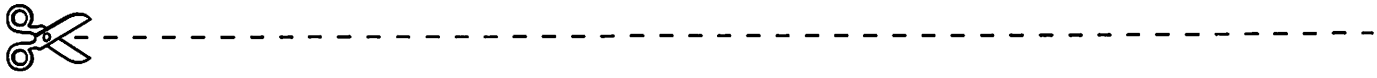

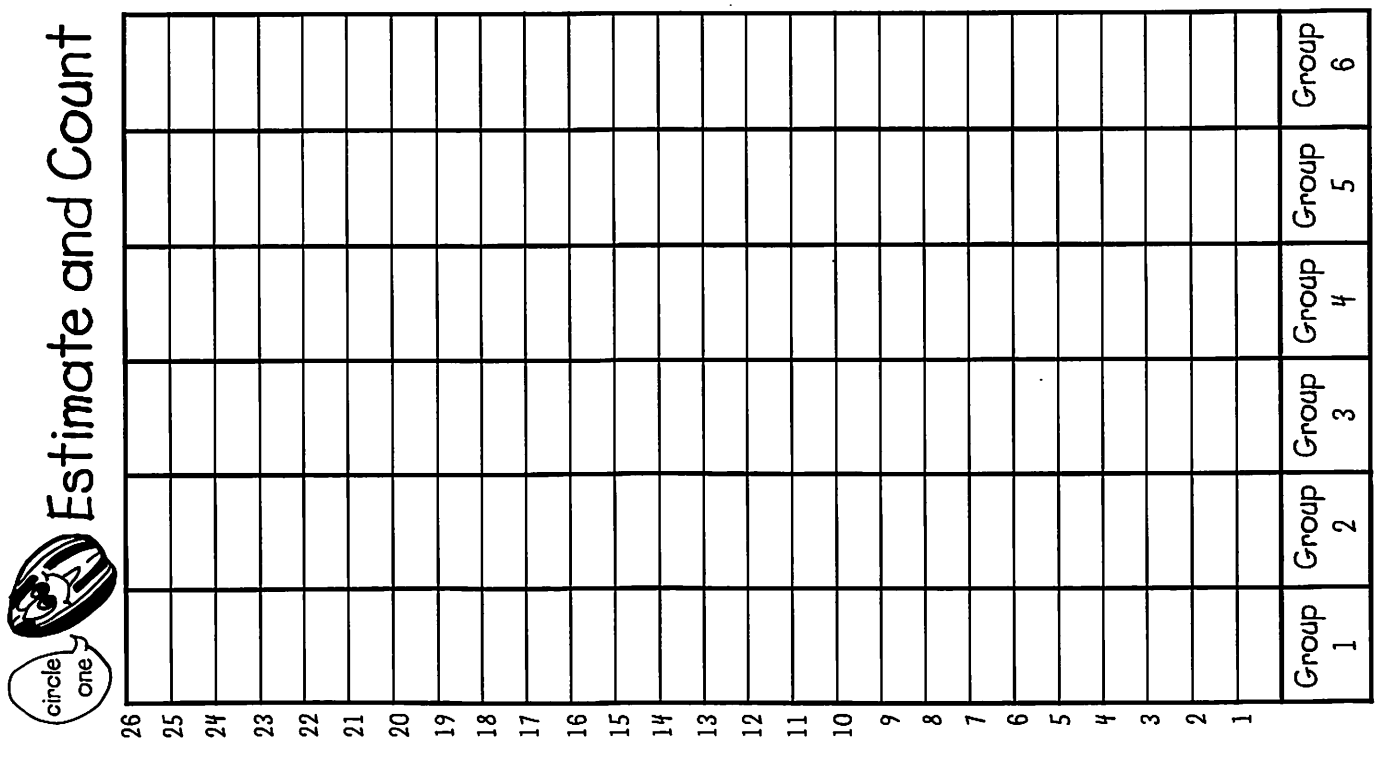
Estimate and Count
circle one
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6
26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

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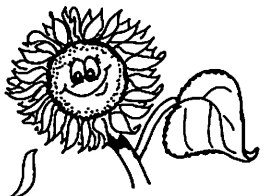
Station 1

Observe



Colors I see

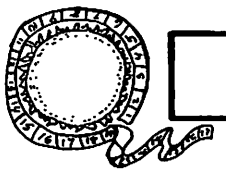
Petals I count

Estimate

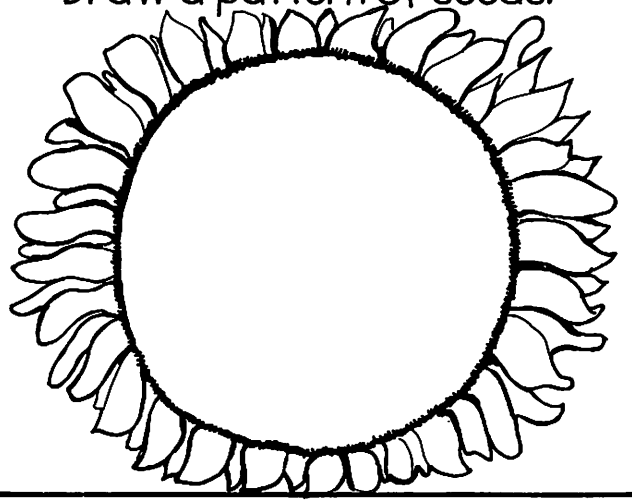
Count

Measure across

Measure around

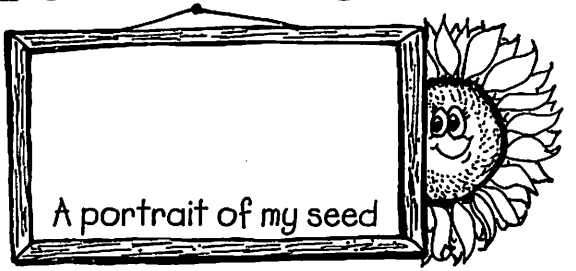


Draw a pattern of seeds.



Station 2

Explore a Seed



Looks

Smells

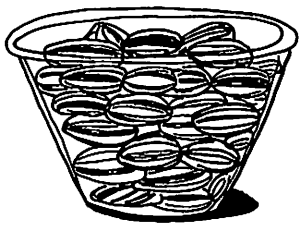
Feels

Sounds

Shape

Station 3

How many seeds in the cup?

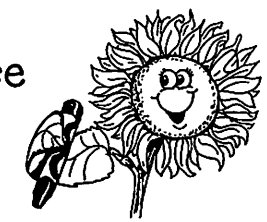


1. Estimate

2. Count

3. Graph
   Color in your estimate on the left side of the graph.
   Color in your real count on the right side of the graph.

4. What is the difference in the columns?

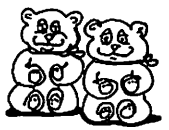


5. Record your group's data on the class graph.

Station 4

Balancing

1. How many unshelled seeds will balance two bears?



Estimate

Count

2. Now use seeds without shells.

How many shelled seeds will balance two bears?

Estimate

Count

3. What was the difference?

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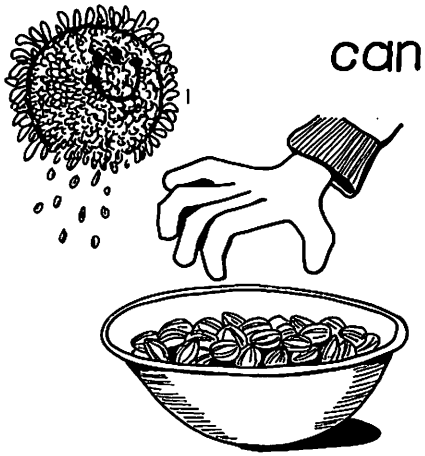
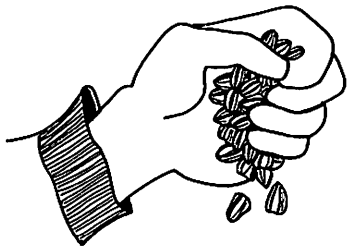
Station 5

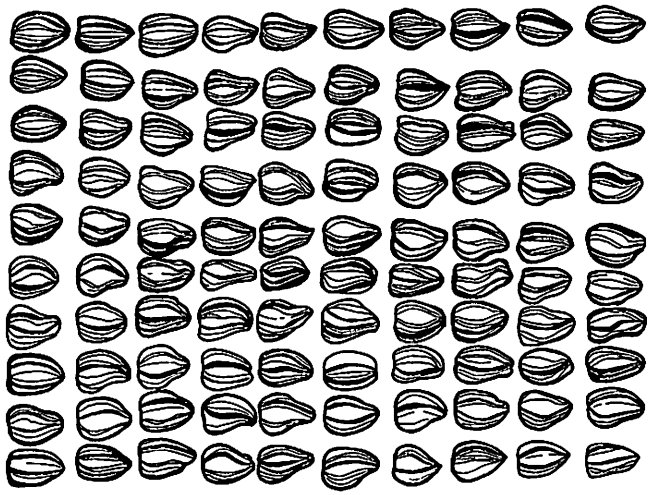
How many seeds can you pick up?





Estimate: ☐ Count: ☐

Color the number of seeds you picked up.



100 Seeds

Station 6

Sink or Float?

1. Put 10 sunflower seeds in water.

I think the seeds will _____.
float or sink

The seeds _____.
floated or sank

2. Put 10 seeds without shells in the water.

I think the seeds will _____.
float or sink

The seeds _____.
floated or sank

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Activities Integrating Math, Science, & Technology — AIMS

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